

# 5/1/2018 - Meeting 49

Tuesday, May 1, 2018

11:31 AM

## 11:00 – Review Budget

## 11:15 - Review Design Report

### System architecture:

describe components and how they satisfy requirements

### Design evaluation:

explain oil testing procedure and it's importance, explain torque testing/efficiency validation (Gabe has this handled)

### Future work:

Optimal gears and cross roller bearing, explain pros and cons, conduct cost evaluation

Explain pros and cons conduct cost evaluation

### Appendices

All product pages and calculations

### Roles/Responsibilities

Brad: Conducted material/life analyses on custom components

Spec purchased components

Jake: document team progress,

Maintain budget and project learning archive

Gabe: Perform motor analyses and specify system performance

Daniel: perform FEA on CAD components and create design models

## 11:45- Review Documentation cleanup (OneNote, Wiki, etc.

See page outline clean-up progress and needs

Add photos for motor and machining progress

Add photos/videos of testing

Add motor validation results

Add testing outline/report

## 12:00 – continue physical work

Name	<u>Action Item</u>	Due Date
Daniel	<input checked="" type="checkbox"/> Design Report	4/26
	<input checked="" type="checkbox"/> Review and edit work/ <del>writing</del> /documentation done	
	<input checked="" type="checkbox"/> Design evaluation: describe FEA process on difficult geometries like front casing, neck, carrier, shaft	
	<input checked="" type="checkbox"/> Discuss FEA results	
	<input checked="" type="checkbox"/> Future work: FEA on Proto 2 bolt pattern, recommended approach and desired/expected results	
	<input checked="" type="checkbox"/> One Note documentation cleanup - See page outlining needs	

	<input checked="" type="checkbox"/> SW files cleanup	
<b>Gabe</b>	<input checked="" type="checkbox"/> Design Report <ul style="list-style-type: none"> <li><input checked="" type="checkbox"/> System architecture: describe the motors speculated performance and how it should satisfy requirements with custom gearbox</li> <li><input checked="" type="checkbox"/> Design evaluation: describe process by which performance was evaluated, include equipment used, extent of testing, assumptions made, methods used</li> <li><input checked="" type="checkbox"/> Future work: explain additional testing needed, recommend motor driver required, discuss expectations</li> </ul>	4/26
<b>Jacob</b>	<input checked="" type="checkbox"/> Wikipage edits/updates	5/4
	<input checked="" type="checkbox"/> Report intro/	5/4
	<input checked="" type="checkbox"/> Budget finalization	5/4
<b>Brad</b>	<input checked="" type="checkbox"/> Assembly instruction sheet	
	<input checked="" type="checkbox"/> Documentation of optimized gearset (that meshes :) )	5/4
<b>Team milestones</b>	<input checked="" type="checkbox"/> <b>Final documentation wrap-up</b>	5/4
	<input checked="" type="checkbox"/> Final report	5/4
	<input checked="" type="checkbox"/> Testing reports	
	<input checked="" type="checkbox"/> Design drawings	
	<input checked="" type="checkbox"/> Proto 2 calculations	
	<input checked="" type="checkbox"/> Wikipage finalized	5/4
	<input checked="" type="checkbox"/> Work area checkout (approval needed by Bill, return scrap metal)	
	<input checked="" type="checkbox"/> <b>Design Report</b>	5/4
	<input checked="" type="checkbox"/> System Architecture	
	<input checked="" type="checkbox"/> Design Evaluation	
	<input checked="" type="checkbox"/> Future Work	
	<input checked="" type="checkbox"/> <b>Client work delivery on flash drive</b>	5/7
	<input checked="" type="checkbox"/> Full format powerpoint with videos	
	<input checked="" type="checkbox"/> Full resolution copy of poster (pdf & pptx)	
	<input checked="" type="checkbox"/> PDF of OneNote documentation	
	<input checked="" type="checkbox"/> OneNote local copy including all datasheets/testresults etc. (---.onepkg---)	
	<input checked="" type="checkbox"/> Solidworks files of Proto 1, Proto 2, and TG5153 Motor assemblies (as pack-and-go assemblies)	
	<input checked="" type="checkbox"/> IGS documentation of optimized gearsets	
	<input checked="" type="checkbox"/> Initial motor analysis/selection spreadsheet	
	<input checked="" type="checkbox"/> Updated team budget	
	<input checked="" type="checkbox"/> Prototype testing results	
	<input checked="" type="checkbox"/> All photos/videos of project accumulated	
	<input checked="" type="checkbox"/> Design Report pdf	

# 4/24/18 - Meeting 48

Tuesday, April 17, 2018 11:04 AM

## 11:00 – Review PowerPoint presentation outline

- Plan transitions
  - Same as design review
- Topic ownership
  - Same as design review, Gabe will stay at the booth
  -
- Time
  - 18 minutes including questions
  - 15 minutes talking time max
- Number of slides
  - No more than 15
- Pictures needing updates
  - Torque validation
  - Design renders
  - Proto 2 renders?
- Plots to include
  - Efficiency analysis
- EXPO Booth:
  - Acrylic backing plate mounted
  - Spray paint the wooden base
  - 21" monitor borrowed
  - Poster on easel
  - Metal backing plate loose for discussion
- Practice session on Thursday 4/26 at 11:00

## 11:15 – Prepare for Expo and final wrap-up

Bastian would like a finalized gearbox design that is small, lightweight, for mass production

Proto 2 optimized design features:

Optimized Gears designed

Crossed roller bearings

Short length

Plan on 25-30 minute conversation for final presentation to Bastian

25-30 slides, more technical, more in depth, client specific information

## 11:30 – Overall team status update with Hans via Skype

Clarification of expectations for presentation and demonstration

Demonstration

Put on table and spin through speed range

Presentation topics

What needs done to make it a full fledged product?

Send slides to Hans by Thursday evening

Slide or 2 summarizing improvements to make

## Trip to Bastian

Scheduled for 4/30, drive down Sunday

Leave steam plant lot no later than 2, stopping for dinner somewhere on the way (McCall)

Staying at Best Western

Present Monday to Bastian starting at 8:30, presentation at 9:00, departure at \_\_\_\_\_ return to moscow that night

## Review testing results

Motor driver is insufficient for the full range of testing

Assuming even 90% efficiency for the MOSFETS on the motor driver, max output is ~548 Watts, at 95% motor efficiency, this leave an available ~500 Watts

Oil fill was validated

Gearbox efficiency plateaus near 87% for 6:1 planetary systems

Impact testing is underway

Motor driver is repaired, testing to see if it works will occur today

## 11:45 – assign action items

## 12:00 – continue physical work

Action items to be assigned:

Name	<u><b>Action Item</b></u>	Due Date
Daniel	<input checked="" type="checkbox"/> Powerpoint for EXPO Meeting at 3:30 to finish	4/26
Gabe	<input checked="" type="checkbox"/> Powerpoint for EXPO	4/26
Jacob	<input checked="" type="checkbox"/> Design Report Start	4/26
Brad	<input checked="" type="checkbox"/> Document IGS Gearset <input checked="" type="checkbox"/> Assembly instruction sheet <input checked="" type="checkbox"/> Bearing analysis of crossed roller bearings <input checked="" type="checkbox"/> Black Spraypaint	4/27
POSTER	<input checked="" type="checkbox"/> Plots from dyno <input checked="" type="checkbox"/> Heat map <input checked="" type="checkbox"/> Proto 2 snapshot <input checked="" type="checkbox"/> Gear TK Code snipping/governing equations <input checked="" type="checkbox"/> Pictures of Proto 1 <input checked="" type="checkbox"/> Team Picture <input checked="" type="checkbox"/> Team Watermark	4/23
Team milestones	<input checked="" type="checkbox"/> EXPO prep	4/26
	<input checked="" type="checkbox"/> Powerpoint creation	4/24
	<input checked="" type="checkbox"/> Poster created	4/22
	<input checked="" type="checkbox"/> Videos loaded on laptop for display	4/26
	<input checked="" type="checkbox"/> Determine presenters for each section, trade off similar to design review	4/23
	<input checked="" type="checkbox"/> Practice presentation twice	4/25
	<input checked="" type="checkbox"/> Swap to clear back casing for display	4/26
	<input checked="" type="checkbox"/> Light strip??	

<input checked="" type="checkbox"/>	Final documentation wrap-up	5/4	
<input checked="" type="checkbox"/>	Final report	5/4	
<input checked="" type="checkbox"/>	Testing reports		
<input checked="" type="checkbox"/>	Design drawings		
<input checked="" type="checkbox"/>	Proto 2 calculations		
<input checked="" type="checkbox"/>	Wikipage		
<input checked="" type="checkbox"/>	Present to Bastian	4/30	
<input checked="" type="checkbox"/>	Powerpoint		
<input checked="" type="checkbox"/>	Hardware delivery		
<input checked="" type="checkbox"/>	Final test analysis completed		
<input checked="" type="checkbox"/>	Photos of EXPO booth		

# 4/17/18 - Meeting 47

Tuesday, April 17, 2018 11:04 AM

## 11:00 – Review Testing outcomes:

- Oil validation results
  - Ideal oil fill level
  - Oil type used
  - Efficiency results
  -
- Dyno test results
  - Troubleshooting
  - Efficiency analysis
  - Next steps

## 11:15 – Prepare for Expo and final wrap-up

Bastian would like a finalized gearbox design that is small, lightweight, for mass production

Proto 2 optimized design features:

- Optimized Gears designed
- Crossed roller bearings
- Short length

## 11:30 – Overall team status update with Hans via Skype

### Trip to Bastian

Scheduled for 4/30, drive down Sunday, present Monday to Bastian, return that night

### Review testing results

Motor driver is insufficient for the full range of testing

Assuming even 90% efficiency for the MOSFETS on the motor driver, max output is ~548 Watts, at 95% motor efficiency, this leave an available ~500 Watts

Oil fill was validated

Impact testing is underway

## 11:45 – assign action items

## 12:00 – continue physical work

Action items to be assigned:

Name	<u><b>Action Item</b></u>	Due Date
Daniel	<input checked="" type="checkbox"/> Extrapolate and polish dyno data with Gabe	
	<input checked="" type="checkbox"/> Proto 2 CAD (Round	
	<input checked="" type="checkbox"/> Finished gears are emailed from BRAD	
	<input checked="" type="checkbox"/> Powerpoint for EXPO	
Gabe	<input checked="" type="checkbox"/> Extrapolate and polish dyno data with Daniel	

	<input checked="" type="checkbox"/> Powerpoint for EXPO	
Jacob	<input checked="" type="checkbox"/> Design Report Start	
Brad	<input checked="" type="checkbox"/> Document IGS Gearset	3/30
	<input checked="" type="checkbox"/> Assembly instruction sheet	
	<input checked="" type="checkbox"/> Bearing analysis of crossed roller bearings	
POSTER	Plots from dyno Heat map Proto 2 snapshot Gear TK Code snipping/governing equations Pictures of Proto 1 Team Picture Team Watermark	
Team milestones	<input checked="" type="checkbox"/> Dyno motor	
	<input checked="" type="checkbox"/> Extrapolate results and interpret	4/17
	<input checked="" type="checkbox"/> EXPO prep	4/26
	<input checked="" type="checkbox"/> Powerpoint creation	4/24
	<input checked="" type="checkbox"/> Poster created	4/22
	<input checked="" type="checkbox"/> Videos loaded on laptop for display	4/26
	<input checked="" type="checkbox"/> Determine presenters for each section, trade off similar to design review	4/23
	<input checked="" type="checkbox"/> Practice presentation twice	4/25
	<input checked="" type="checkbox"/> Swap to clear back casing for display	4/26
	<input checked="" type="checkbox"/> Light strip??	
	<input checked="" type="checkbox"/> Final documentation wrap-up	5/4
	<input checked="" type="checkbox"/> Final report	5/4
	<input checked="" type="checkbox"/> Testing reports	
	<input checked="" type="checkbox"/> Design drawings	
	<input checked="" type="checkbox"/> Proto 2 calculations	
	<input checked="" type="checkbox"/> Wikipage	
	<input checked="" type="checkbox"/> Present to Bastian	4/30
	<input checked="" type="checkbox"/> Powerpoint	
	<input checked="" type="checkbox"/> Hardware delivery	
	<input checked="" type="checkbox"/> Final test analysis completed	
	<input checked="" type="checkbox"/> Photos of EXPO booth	

# 3/27/18 - Wikipage Notes

Tuesday, March 27, 2018 3:21 PM

Grading Rubric/Checklist: use the **Wikipage Form** on mindworks

Have text flow around images (have images on left hand side)

Validation - pictures of testing (dyno)

Keep going with DESIGN CONCEPT

Add PROJECT LEARNING



# 4/10/18 - Meeting 46

Monday, April 9, 2018

10:50 PM

## 11:00 – Review Testing outcomes:

- Oil validation results
  - Ideal oil fill level
  - Oil type used
  - Efficiency results
  -
- Dyno test results
  - Troubleshooting
  - Efficiency analysis
  - Next steps
  - Thermal results

## 11:15 – Determine impact testing design

Drum idea is more representative of actual obstacles  
Lawn mower or training wheels  
Always save wheels

## 11:30 – Overall team status update with Hans via Skype

### Trip to Bastian

Scheduled for 4/30, drive down Sunday, present Monday to Bastian, return that night

### Review testing results

Motor driver is insufficient for the full range of testing

Assuming even 90% efficiency for the MOSFETS on the motor driver, max output is ~

548 Watts, at 95% motor efficiency, this leave an available ~500 Watts

Oil fill was validated

Impact testing is underway

## 11:45 – assign action items

## 12:00 – continue physical work

Action items to be assigned:

Name	<u>Action Item</u>	Due Date
Daniel		
Gabe		
Jacob	<input checked="" type="checkbox"/> Compile OneNote, final report prep	4/20
	<input checked="" type="checkbox"/> Final Report outline	3/23
	<input checked="" type="checkbox"/> Where and what everything goes	4/1
	<input checked="" type="checkbox"/> Wikipage workshop 3:30-4:00	3/27
	<input checked="" type="checkbox"/> More pictures, less math	
	<input checked="" type="checkbox"/> Reports needed for each math/analysis section as PDFs	4/15 (from team)

	that downloadable (each team member will give as needed)	
<b>Brad</b>	<input checked="" type="checkbox"/> Document IGS Gearset	<b>3/30</b>
<b>Team milestones</b>	<input checked="" type="checkbox"/> Dyno motor	<b>3/30-4/8</b>
	<input checked="" type="checkbox"/> Dyno test motor	<b>4/2</b>
	<input checked="" type="checkbox"/> Impact test	<b>4/3-5</b>
	<input checked="" type="checkbox"/> EXPO prep	<b>4/8-4/26</b>
	<input checked="" type="checkbox"/> Final documentation wrap-up	<b>4/26</b>
	<input checked="" type="checkbox"/> Final report	<b>4/29</b>
	<input checked="" type="checkbox"/> Testing reports	
	<input checked="" type="checkbox"/> Design drawings	
	<input checked="" type="checkbox"/> Proto 2 calculations	
	<input checked="" type="checkbox"/> Present to client	<b>4/30</b>

# 3/27/18 - Meeting 45

Tuesday, March 27, 2018 10:06 AM

11:00 – determine needs for dyno testing and oil validation

- Oil validation:
  - Turkey baster to measure oil level
  - Run motor through speed range without dyno
  - Then swap for metal plate, then dyno
- Outline design guidelines
  - Mounting plate for bare motor
  - Mounting plate for gearbox and motor combo
    - Use wood for both
  - Shaft adaptors
    - from gearbox plate to  $\frac{3}{4}$ "
    - From motor to  $\frac{3}{4}$ "
- Determine build timeline
  - Plywood already secured
  - Cut plywood (3/29)
  - Design shaft adaptors (3/27)
  - Machine shaft adaptors (3/30 and 4/2)
- Execution order:
  - Acrylic backing assembly
  - Sealing acrylic
  - Turkey basting oil into the gearbox
  - Swap for aluminum back
  - Add adaptors
  - Mount to dyno
  - Run dyno
- Duty cycle for dyno:
  - Code time functions for voltage control input
    - Slowly throttle up to 4500

11:15 – Determine impact testing design

Drum idea is more representative of actual obstacles

Lawn mower or training wheels

Always save wheels

11:30 – Overall team status update

Trip to Bastian

Scheduled for 4/30, drive down Sunday, present Monday to Bastian, return that night

11:45 – assign action items

12:00 – continue physical work

Action items to be assigned:

Get ideas hashed out for attaching motor to dyno,  
pursue construction thereof asap.

Acrylic Backing:

Get acrylic plates together,  
 seal set  
 Fasten to case and motor without damage.  
 Begin oil validation.  
 (Perhaps with multiple oils and test each at their optimal fill level on the dyno?)  
 Magnetize our bolt if possible.  
 Look into the breather tube deal if Swenson says it is absolutely necessary.  
 Get individual analyses compiled into presentable fashions.  
 Get a dyno plan laid out: what cycles we want to run through with each oil via gearbox and naked motor. We also need a coupler for the naked motor shaft to get baseline dyno values.  
 We need a separate mount/coupler for the naked motor on the dyno

Name	<u><b>Action Item</b></u>	Due Date
Daniel	<input checked="" type="checkbox"/> Purchase washers, screws, oil	3/22
	<input checked="" type="checkbox"/> Contact motor repair guy	3/27
	<input checked="" type="checkbox"/> Lasercut files for acrylic backing piece 0.1" layers	3/26
	<input checked="" type="checkbox"/> Glue acrylic together with Gabe	3/27
	<input checked="" type="checkbox"/> Test grapejelly to acrylic	3/27
	<input checked="" type="checkbox"/> Plywood cutting w/Jake/Gabe	3/29
Gabe	<input checked="" type="checkbox"/> Contact motor dyno guy	3/20
	<input checked="" type="checkbox"/> Oder shaft seal duplicate	3/21
	<input checked="" type="checkbox"/> Buy washers, screws, yamabond, oil	3/22
	<input checked="" type="checkbox"/> Obtain keyshaft dimension	3/27
	<input checked="" type="checkbox"/> Glue acrylic w/ Daniel	3/27
	<input checked="" type="checkbox"/> Secure turkey baster w/ Brad	3/27
Jacob	<input checked="" type="checkbox"/> Talk with Dev about information needed for testing	
	<input checked="" type="checkbox"/> Compile OneNote, final report prep	4/20
	<input checked="" type="checkbox"/> Press bearings, pins, gears, assemble design	3/21
	<input checked="" type="checkbox"/> Final Report outline	3/23
	<input checked="" type="checkbox"/> Where and what everything goes	4/1
	<input checked="" type="checkbox"/> Wikipage workshop 3:30-4:00	3/27
Brad	<input checked="" type="checkbox"/> More pictures, less math	
	<input checked="" type="checkbox"/> Reports needed for each math/analysis section as PDFs that downloadable (each team member will give as needed)	4/15 (from team)
	<input checked="" type="checkbox"/> Talk with Dr. Beyerlein/Crepeau about thermal imaging camera Available from Alex in IEW office	3/27
	<input checked="" type="checkbox"/> Document IGS Gearset	3/30
	<input checked="" type="checkbox"/> CAD for keyshaft/adaptors to dyno	3/27
	<input checked="" type="checkbox"/> Secure turkey baster	3/27
Team milestones	<input checked="" type="checkbox"/> Assemble Gearbox	3/23
	<input checked="" type="checkbox"/> Oil fill validation	3/30
	<input checked="" type="checkbox"/> Acrylic backplate assembly	3/27
	<input checked="" type="checkbox"/> Fill oils to determine optimum oil level	3/28
	<input checked="" type="checkbox"/> Measure oil with turkey baster dealio	3/28
	<input checked="" type="checkbox"/> Swap back to aluminum plate	3/30
	<input checked="" type="checkbox"/> Fill with oil	3/30
	<input checked="" type="checkbox"/> Dyno motor	3/30-4/8
	<input checked="" type="checkbox"/> Mounting plate for gearbox	3/30
	<input checked="" type="checkbox"/> Mounting plate for motor	3/30
	<input checked="" type="checkbox"/> Adaptor shafts design – Brad	3/28

<input checked="" type="checkbox"/>	Adaptor shafts building/machining - Brad	4/2	
<input checked="" type="checkbox"/>	Dyno test motor	4/3-5	
<input checked="" type="checkbox"/>	Impact test	4/8-4/26	
<input checked="" type="checkbox"/>	EXPO prep	4/26	
<input checked="" type="checkbox"/>	Final documentation wrap-up	4/29	
<input checked="" type="checkbox"/>	Final report		
<input checked="" type="checkbox"/>	Testing reports		
<input checked="" type="checkbox"/>	Design drawings		
<input checked="" type="checkbox"/>	Proto 2 calculations		
<input type="checkbox"/>			

# 3/20/18 - Meeting 44

Tuesday, March 27, 2018 10:21 AM

## 11:00 – Current Progress:

- Keys being cut tomorrow
- Whole unit operational by friday (3/23)
- Laser cutting of window back piece
- Dyno mounting

## 11:15 - Next steps:

- Assemble gearbox
- Buy oil and yamabond
- Testing/validation
- Final report
- Expo prep
- Client visit

## 11:30 – Skype with Hans

- Plan client visit for 4/29-30
- Expo prep is going well
- Discussed proto 2 advantages
- Clarified testing plans.

## 11:45 – Action items and wrap-up

From Swenson:

### **4 critical items for final report**

- 1- drawing packet
- 2 – Assembly instructions
- 3 – Requirements/scope document
- 4 – Validation
  - A) - Paper calculations, FEA, IGS survey, TK solver reports
  - B) - physical tests

## **Action Items:**

### **Gabe**

- ☒ Contact motor dyno guy, figure out shaft adaptor (3/20)
- ☒ Order small shaft seal duplicate (3/21)
- ☒ Buy washers, screws, oil, yamabond/loctite w/Daniel (3/22)

### **Jake**

- ☒ Compile Notes, sections, final report prep
- ☒ Press bearings, gears, pins, assemble design (3/21)
- ☒ Final report outline (3/23)

### **Brad**

- ☒ Document optimized IGS gear set, (3/30)

### **Daniel**

- ☒ Purchase washers, screws, oil with Gabe (3/22)
- ☒ Contact motor driver repair guy in GJ

## **Team items**

- ☒ Assemble Gearbox 3/23
- ☒ Dyno Motor 3/30-4/8
- ☒ Impact test 4/8-Expo
- ☒ EXPO Prep
- ☒ Final Documentation wrap up due

# 3/6/18 - Meeting 43

Tuesday, March 6, 2018 11:16 AM

Add motor operation videos and design review animation to Powerpoint to run on loop for snapshot

Update Gantt to match current status, don't dwell on delays - Swenson

Motor may be permanently damaged

Check pins and connections for wires

Gear drawings for Bill/Coleton to bore out the sun gear and ring gear

Ring gear - counter bore 8-32 on 5.5" bolt circle

Sun gear - counter bore for washer

DO NOT TOUCH sign for snapshot display items

Trouble shoot motor, establish root cause

Gabe will run into ME office and submit green sheet ?today?

Proto 2 questions:

Cost of crossed roller bearing

Idealized gearset configuration.....

Use gear geometries from IGS optimization

## Action Items:

- ☒ Portfolio - 3/9
  - ☒ Jake will be giving action items away on this
  - ☒ Proto 2 pics and screenshots for portfolio and wikipedia, super simple, cross section and ISO
- ☒ Wiki page - 3/9
  - ☒ Jake will be giving action items away on this
- ☒ Team citizenship forms - 3/9
- ☒ **Motor kerfluffle**
  - ☒ Check connections of all phase wires
  - ☒ Shrink wrap wires
  - ☒ Try switching phases?
  - ☒ Possibly contact thingap
  - ☒ Motor driver repair status?
- ☒ **Snapshot prep sections – We are a go!**
  - ☒ Hardware
    - ☒ Power supply
    - ☒ Broken motor driver
    - ☒ Video of motor operating (Brad has saved) - sent in messenger
    - ☒ Bearings and seals (in clear baggies)
    - ☒ Gears (in baggies)
    - ☒ Machined parts (deburr all edges) - Daniel

- ☒ Validation and testing plans - Daniel - Print in color
  - ☒ Design review slides –Daniel
  - ☒ Address concerns from design review 2 - Daniel
- ☒ Drawing Package – Merge completed drawings - Daniel
  - ☒ Add ISO and motor and cross section off full assembly
  - ☒ Backplate needs updated (notation) - Brad
  - ☒ Carrier guide drawing - Brad
  - ☒ Output carrier needs creation – Jake and Gabe
- ☒ Schedule - Daniel
  - ☒ Update to match current progress (behind schedule)
- ☒ Budget – Jake
  - ☒ Itemized prototype budget
  - ☒ Team budget
- ☒ Gabe & Brad & Jake : Gcode for LBC-plate
- ☒ Gabe: Document collision model
- ☒ Gabe : order remaining parts
- ☒ Get part numbers – Brad and Jake
  - Flatheads for: sun gear fastening, carrier to output shaft fastening, output to guide fastening
  - Washer for sun gear
  - 6-bearings for planets
  - Dowels
  - Offsets/standoffs?
- ☒ All of us: Figure out testing apparatus
  - Don't make wheel?
  - Use brake rotor from Daniel's old bike
  - Brad will finalize design with help from Jake
- ☒ Daniel – buy Yamabond from NAPA
  - ☒ Bought grape jelly instead (Loctite 519)
- ☐



# 3/1/18 - Meeting 42

Thursday, March 1, 2018 11:04 AM

## Gearbox:

Project scope is not entirely narrowed down to gearbox,  
Bastian is still interested in the TG5153

Testing won't be life span reflective due to softer gear material

Gear life combinations already run for 4 optimal gear sets (duty cycle might be overkill)

Life safety factor is hard to calculate – Brad

Designing for  $10^9$  cycles

Longterm design solutions:

<https://www.mcmaster.com/#2010n24/=1bs8hx1>

^^Fancy bearing

Get rid of neck, use thicker material and fancy bearing

This shaves off 0.8 inches, and eliminates the need for an output shaft?

[http://www.ikont.com/catalogs/needle-roller-bearing-series/5508\\_3\\_E\\_CRB.pdf](http://www.ikont.com/catalogs/needle-roller-bearing-series/5508_3_E_CRB.pdf)

## Action Items:

- ✓ **Snapshot prep sections**
  - ✓ Hardware
    - ✓ Power supply
    - ✓ Broken motor driver
    - ✓ Video of motor operating (Brad has saved)
    - ✓ Bearings and seals (in clear baggies)
    - ✓ Gears (in baggies)
    - ✓ Machined parts (deburr all edges) - Daniel
  - ✓ Validation and testing plans - Daniel
    - ✓ Design review slides –Daniel
    - ✓ Address concerns from design review 2 - Daniel
  - ✓ Drawing Package – Merge completed drawings - Daniel
    - ✓ Backplate needs updated (notation) - Brad
    - ✓ Carrier guide drawing - Brad
    - ✓ Output carrier needs creation – Jake and Gabe
  - ✓ Schedule - Daniel
    - ✓ Update to match current progress (behind schedule)
  - ✓ Budget – Jake
    - ✓ Itemized prototype budget
    - ✓ Team budget
- ✓ Gabe & Brad & Jake : Gcode for LBC-plate
- ✓ Gabe: Document collision model
- ✓ Jake: order remaining parts
  - ✓ **Get part numbers – Brad and Jake**
    - Flatheads for: sun gear fastening, carrier to output shaft fastening, output to guide fastening
    - Washer for sun gear
    - 6-bearings for planets

- Dowels
- Offsets/standoffs?



All of us: Figure out testing apparatus

- Don't make wheel?
- Use brake rotor from Daniel's old bike
- Brad will finalize design with help from Jake



Daniel – buy Yamabond from NAP<sup>A</sup>

# 2/27/18 - Meeting 41

Tuesday, February 27, 2018 11:08 AM

## **Machining Update:**

Load bearing carrier is finished

Need to finish g-code for guide carrier by Friday this week, Brad and Jake

## **Ordering of parts**

Ordering bearings for planet gears – Jake

Dowel pins

Fasteners

Offsets

Big washers

## **Snapshot:**

Swenson wants to see hardware, validation and testing plans

Schedule, budget, drawing package

Make video of motor spinning with screen capture of serial plotter, serial print and other information from Arduino

## **Portfolio, Wiki-page, Team member citizenship**

Technically Due 3/6, Swenson wants it "before we leave for spring break"

Money shot is a cross sectional view of the gearbox and full system

## **Wikipage:**

Objectives

Requirements

Design

Division of subsystems (selection process, unique features, materials, critical analysis)

Motor

Planetary gear set

Output shaft/hub

Bearings

Validation:

Verification

Proof on paper (stress simulation, FEA, geometric analysis, gear life)

Functional Validation (plan as of now)

Speed

Torque

*Thermal testing?*

Oil

Durability Testing: (as currently planned)

Drum impact test

Duty cycle and thermal management

*Thermal testing?*

Longer bench testing

Client visit scheduled for April 30<sup>th</sup>

Bastian is interested in steps needed to make the design ready for industrial usage

^ Present during client visit

### Action Items:

- ☒ Snapshot prep
- ☒ All of us: Figure out testing apparatus
  - Don't make wheel?
  - Use brake rotor from Daniel's old bike
  - Brad will finalize design with help from Jake
- ☒ Daniel – buy Yamabond from NAPA
- ☐
- ☒ Gabe & Brad & Jake : Gcode for LBC-plate
- ☒ Gabe: Document collision model
- ☒ Jake: order parts
  - Flatheads for: sun gear fastening, carrier to output shaft fastening, output to guide fastening
  - Washer for sun gear
  - 6-bearings for planets
  - Dowels
  - Offsets/standoffs?

## 2/22/18 - Meeting 40

Tuesday, February 27, 2018 11:02 AM

### Team Meeting 40

(89)

2/22/18

#### John Plans

Grabe: Meet w/ Ankit @ 2:30 today  
to get motor fixed up.

Brad: Get my Arduino to Grabe  
for his action item

Take: Continue on Drawing package

Daniel: Check Drawings, perform  
FEA on simple triangle  
idea with central screw &  
washer

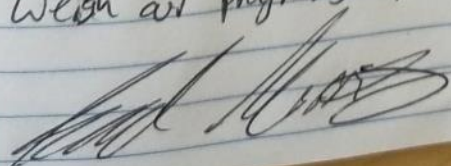
Brad: Create simple triangle for  
Daniel. Present a couple  
options to Bill regarding our  
FEA analysis. Also, make  
CAD once Bill decides.

1st: Get FEA & options to Bill → Tomorrow

2nd: Get First Case drawing to Bill → Monday  
and Skeleton.

Weigh out progress tomorrow evening

et



# 2/20/18 - Meeting 39

Tuesday, February 20, 2018 5:15 PM

## Gears:

- Center Bore of planets will be difficult due to centering issues – Odom
  - Use a collet – Odom
  - We can use ANSI Reamers because bears are ANSI – Brad
  - Will gears walk? – Odom
    - Andres suggests that gears will not walk – Brad
    - Hitting three press fits simultaneously will be difficult - Odom
    - Make one a press and another a slide – Bill

## Motor shaft:

- Make 1/8 in key slot and stepped key – Bill
  - We already have 1/8 in key stock – Bill
  - Take 4 thou of each side of key – Bill

## Output shaft:

- Currently produces too large of stresses – Brad
  - May use similar method as for Motor shaft – Brad
- Why does shaft need to be  $\frac{3}{4}$  in – Odom
  - Why does flange need to be so big? – Coleton, Odom, Bill
  - It is a lot of material to take off – Odom
  - Will be quick to machine though – Odom

## Output Carrier

- What is the tolerance needed – Odom
- There is a lot of side loading potentially – Bill
  - Use threads on Carrier plate and use standoff – Bill
  - 4-40 will allow 9 threads in the 0.2 in – Bill
- FEA may not be accurate – Odom
  - Why use triangular profile, should use spline – Odom
    1. Can spline out of shop, just need \$90 - Odom
  - Use press fit pins, use slots in plate, perpendicular to shaft – Bill
    1. Hardened steel pins shouldn't cause any issues – Gabe
    1. Pins have twice the strength of plate – Odom

## Clearance in Gearbox – Brad

- Don't be worried, clearance is clearance – Odom
- What about wobble – Daniel
  - You will just have to redo the spacers – Bill

## Machining and Building

- We may not be able to participate in all of the machining – Odom
  - Some machining may have to be done for us by Bill or Coleton – Odom
- Bill and Coleton will do the mill and lathe work – Bill
- I expect to see all of you in the shop - Odom

## Aligning Casing – Odom

- It is completely necessary to add dowels for alignment – Odom
  - Use at least 2 dowels – Odom

Odom's job is to make sure that everyone finishes their machining for their respective projects – Odom

For prototyping purposes, nothing has to be final or perfect and can be noted in report as to what is necessary in actual production – Gabe, Swenson, Jake

### Action Items:

- Machining tomorrow
  - Carrier plate
  - Bill needs full drawing of output shaft to machine
  - Need to get SolidCam going
  - Need to consolidate drawings

From <<https://outlook.office.com/owa/?realm=uidaho.edu>>

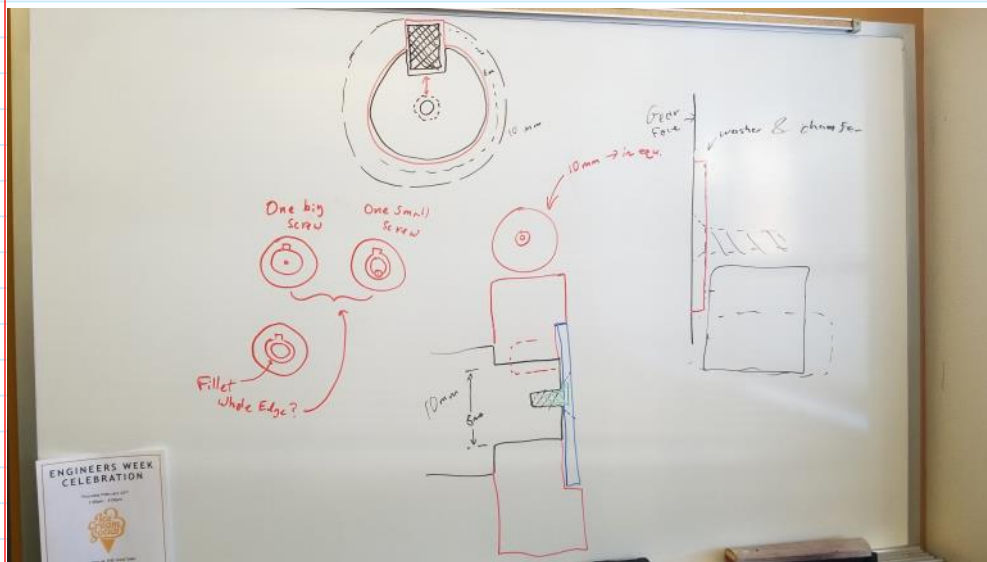
### Action Items:

- ✓ All of us: Figure out testing apparatus
  - Don't make wheel?
  - Use brake rotor from Daniel's old bike
  - Brad will finalize design with help from Jake
- ✓ We need to order Grape Jelly (preferably Smuckers)
- ✓ Gabe & Jake: Gcode for LBC-plate
- ✓ Gabe: Document collision model
- ✓ Gabe: order parts
  - Flatheads for: sun gear fastening, carrier to output shaft fastening, output to guide fastening
  - Washer for sun gear
  - 6-bearings for planets
  - PEMs
  - dowels

# 2/13/18 - Meeting 38

Tuesday, February 13, 2018 11:12 AM

- Confirm new design with Dr. Swenson
  - Absent from meeting
- New machining timeline/Parts to order
  - PEM standoffs - 4-40 MD = 0.122, HD = 0.255
  - Flathead screws
    - For standoff -
    - For shaft
  - Bearings - 60355K861 (Mcmaster car), \$3.12 each, plain seal
  - We need to figure out how to attach sun gear to motor shaft
    - Use 4-40 washer, number 8 flathead
  - Timeline (2/13/17) start next week
    - Monday - Wed: Complete carrier guide, order parts
    - Friday: Face Output Carrier
    - Monday: Finish Output Carrier



## Action Items:

- ✓ All of us: Figure out testing apparatus
  - Don't make wheel?
  - Use brake rotor from Daniel's old bike
  - Brad will finalize design with help from Jake
- ✓ We need to order Grape Jelly (preferably Smuckers)
- ✓ Gabe & Jake: Gcode for LBC-plate
- ✓ Gabe: Document collision model
- ✓ Gabe: order parts
  - Flatheads for: sun gear fastening, carrier to output shaft fastening, output to guide fastening
  - Washer for sun gear
  - 6-bearings for planets
  - PEMs
  - dowels



# 2/8/17 - Meeting 37

Thursday, February 8, 2018 11:03 AM

## Agenda 37

### Team meeting

#### Attendees:

Daniel Hien, Brad Morris, Gabe Riggs, Jacob Riggs

**Summary:** Design Review, Action items (old items review and new items assignment).

#### Proceeding:

##### 11:00 – Design Review

Does it show how we have addressed requirements?

Does it show how we have implemented improvements since last review?

Add drawing package appendix?

Add supporting calculations appendix? I.e., gear life calcs., FEA, etc.

Divide up talking points

Jake: 1-6 & Impact, Gabe: 6-8 & Torque, Brad: 9-12 & Oil Fill, Daniel: 15-18, Thermal, Questions

##### 12:00 – Action items / Q & A

##### 12:05 – End meeting

## Action Items:

- ✓ All of us: Figure out testing apparatus
  - Don't make wheel?
  - Use brake rotor from Daniel's old bike
  - Brad will finalize design with help from Jake
- ✓ Daniel: Get weight of gearbox using CAD estimation to compare with actual weight - Daniel due 1/22
- ✓ Daniel: Create animation for design review #2, due 2/1
- ✓ Jacob: Start making powerpoint (refer to Brad's text)
  - ✓ Include progress, questions, etc. here: [Design Review #2 Prep](#)
- ✓ Gabe & Jake: Gcode for LBC-plate
- ✓ Gabe: Document collision model
- ✓ Brad: draw dot io for testing
- ✓ We need to order Grape Jelly (preferably Smuckers)

# 2/6/18 - Meeting 36

Tuesday, February 6, 2018 11:09 AM

## Agenda 36

### Team meeting

#### Attendees:

Daniel Hien, Brad Morris, Gabe Riggs, Jacob Riggs

**Summary:** Testing apparatus, Design Review (what to include, look at Mindworks for ideas, reserve a room), Action items (old items review and new items assignment).

#### Proceeding:

#### 11:00 – Testing apparatus

- Swenson thinks it's a good idea, but has concern about how much time it will take
  - Therefore he suggests to talk to EE's about an electric motor dyno

#### 11:05 – Design Review (Due date February 9<sup>th</sup>)

- Solution slides (meaty part)
  - Factors that went into our decision and how we made them and how we satisfied requirements
- Bring parts already made
- Testing: call it Validation instead (meaty part)
  - Pictures, sketches, hardware to help people visualize what we're going to do
- Costs
  - Simple cost sheet
- Swenson likes layout
- Reserved room: ME conference room 9:00-11:00

#### 12:00 – Action items / Q & A

#### 12:05 – End meeting

### Action Items:

- ✓ All of us: Figure out testing apparatus
  - Don't make wheel?
  - Use brake rotor from Daniel's old bike
  - Brad will finalize design with help from Jake
- ✓ Daniel: Get weight of gearbox using CAD estimation to compare with actual weight - Daniel due 1/22
- ✓ Daniel: Create animation for design

review #2, due 2/1

- ✓ Jacob: Start making powerpoint (refer to Brad's text)
  - ✓ Include progress, questions, etc.  
here: [Design Review #2 Prep](#)
- ✓ Gabe & Jake: Gcode for LBC-plate
- ✓ Gabe: Document collision model
- ✓ Brad: draw dot io for testing
- ✓ We need to order Grape Jelly (preferably Smuckers)

# 2/1/18 - Meeting 35

Thursday, February 1, 2018 11:06 AM

## Agenda 35

### Team meeting

#### Attendees:

Daniel Hien, Brad Morris, Gabe Riggs, Jacob Riggs

**Summary:** Machining Progress (estimate for new completion date?), Design Review (what to include, look at Mindworks for ideas), Action items (old items review and new items assignment).

#### Proceeding:

##### 11:00 – Machining Progress

- The backplate is roughed and ready for finishing details
- Prep can be done the day before (ban saw can be used)
- Get her done!

##### 11:05 – Design Review (Due date February 9<sup>th</sup>)

Slides: (Refer to image to right for Outline)

- Final motor chosen (Motor spinning video)
  - o Why we chose
- Gearbox final design (thorough reasons/justifications for choice)
  - o Shaft
  - o NLB/LB C-plates
  - o Front and back plates
  - o Gears
- Budget update
  - o Project costs
  - o Final cost of actual prototype
- When we will be done machining prototype gear box
  - o Videos of machining
  - o Pics of machined parts
- Test apparatus
  - o Need break caliper

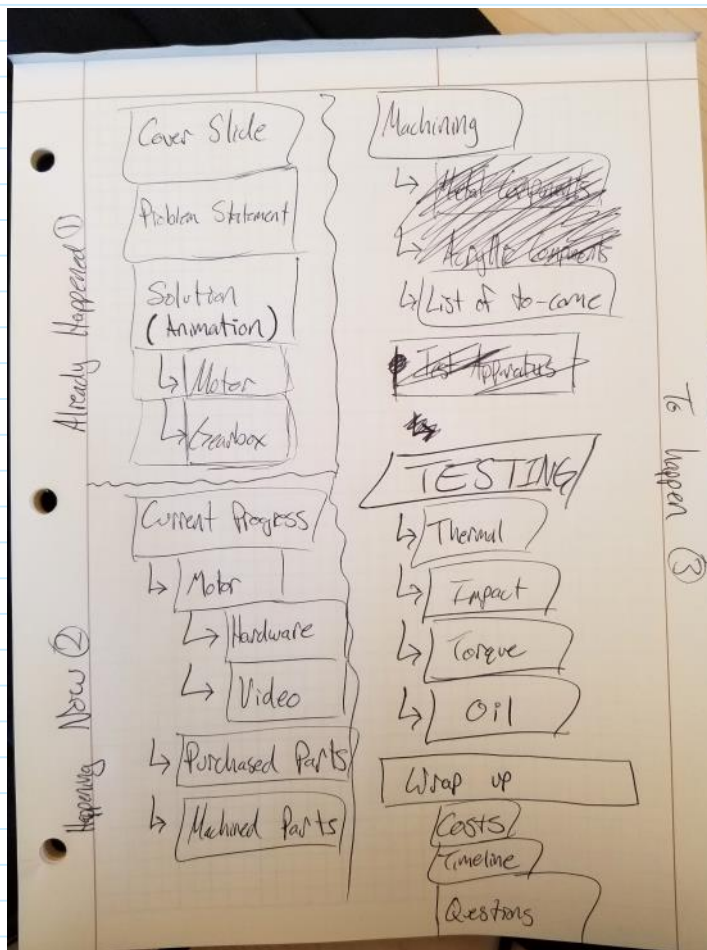
##### 12:00 – Action items / Q & A

##### 12:05 – End meeting

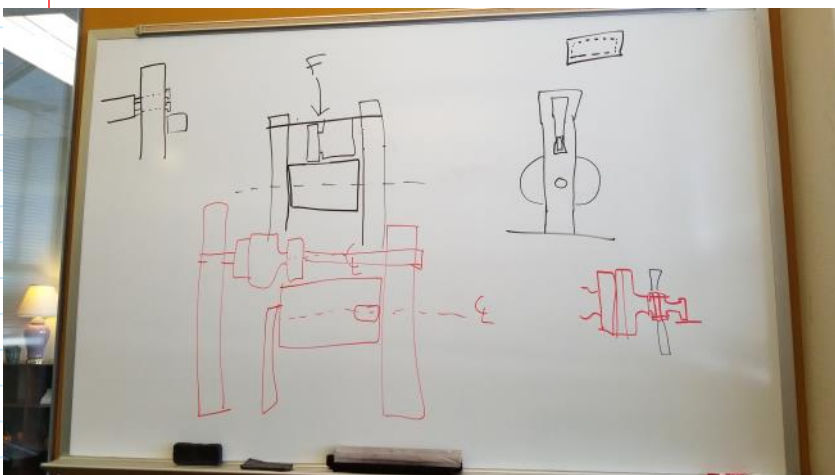
### Action Items:

- ✓ All of us: Figure out testing apparatus
  - Don't make wheel?
  - Use brake rotor from Daniel's old bike
  - Brad will finalize design with help from Jake
- ✓ Daniel: Get weight of gearbox using CAD estimation to compare with actual weight - Daniel due 1/22
- ✓ Daniel: Create animation for design review #2, due 2/1
- ✓ Jacob: Start making powerpoint (refer to Brad's text)
  - ✓ Include progress, questions, etc. here: [Design Review #2 Prep](#)
- ✓ Gabe & Jake: Gcode for LBC-plate
- ✓ Gabe: Document collision model
- ✓ Brad: draw dot io for testing

## Design review ppt. layout



## Testing apparatus



# 1/25/18 - Meeting 33

Thursday, January 25, 2018 11:11 AM

## Notes:

Discussed test apparatus design, see images below

Discussed shop work scheduling:

We would like to cut all material down to size ASAP, can rough cutting material and G-code creation run in parallel?

Coleton would like to start g-code creation today (1/25)

Will meet with Daniel at 3:30 in GJ-115

Jake: we can make our motor/gearbox holding bracket the same for our test apparatus and for our final deliverable

## Team status:

Gabe is updating collisionmodel and tracking down motor driver and power supply

Brad and Jake will share the test apparatus design

Daniel is creating G-code and updating SW model with seal shelf

## Action Items

- ✓ Gabe: Track down power supply,
- ✓ Document collision model due: 1/30 meeting
- ✓ Pick up motor driver from Dr. Swenson and take to workbench in senior design suite
- ✓ Get weight of gearbox using CAD estimation to compare with actual weight - Daniel due 1/30
- ✓ Model shelf for output seal into the CAD model
- ✓ Create animation for design review #2, due 2/1
- ✓ Meet with Coleton in GJ 115 for G-code creation
- ✓ Bring in MTB brake for the torque testing
- ✓ Jacob: Start making powerpoint (refer to Brad's text)
  - ✓ Include progress, questions, etc. here: [Design Review #2 Prep](#)
- ✓ Brad: Design CAD of test apparatus for ease of fabrication and assembly, make shop ready, due by end of gearbox production
  - ✓ Spokes for drum
  - ✓ Frame for drum
  - ✓ Square steel tube for swing arm
  - ✓ Plywood baseplate
  - ✓ Sheet-steel for holding different pieces of test assembly (gigantic shared washer idea)
  - ✓ Simulation

# 1/23/18 - Meeting 32

Tuesday, January 23, 2018 11:04 AM

- Part Construction (progress and issues)
  - NLB carrier plate - part warped
    - Faced on one side and caused warping
    - Next time face both sides to reduce warping
    - The plate being machined is metric
      - **Might need to order a metric drill bit (#9) - Daniel**
    - Daniel will double check drawings for this part (dimensions don't seem to be lined up on the drawings)
    - **Ask Bill about using End mill or Reamer - Gabe & Jake**
- Design Expo
  - Going with new title for booth: **"Compact Robotic Wheel Drive "**
  - Official team abstract shown here:

[Bastian Solutions](#) currently utilizes a wheel drive system which is approximately 8 inches long, consisting mostly of their motor and 4:1 planetary gearbox. Our design utilizes a custom 6:1 planetary gearbox and high torque-density motor that halves the size while maintaining required torque and speed outputs.

- Action Items

- ✓ Gabe: Track down power supply,
- ✓ Document collision model
- ✓ Gabe and Brad: Ask Bill about plexiglass for backplate
- ✓ Figure out testing apparatus
  - Don't make wheel?
  - Use brake rotor from Daniel's old bike
- ✓ Talk about wheel at next meeting
- ✓ Get weight of gearbox using CAD estimation to compare with actual weight - Daniel due 1/22
- ✓ Daniel: switch fasteners to 8/32" flathead holes for backplate
- ✓ Model shelf for output seal into the CAD model
- ✓ Cross section view for Gabe for collision model
- ✓ Create animation for design review #2, due 2/1
- ✓ Jacob: Register team for Design Expo
- ✓ Jacob: Start making powerpoint (refer to Brad's text)
  - ✓ Include progress, questions, etc. here: [Design Review #2 Prep](#)
- ✓ Ask Bill about using End mill or Reamer - Gabe & Jake
- ✓ Daniel: Order metric end mill bit if Bill recommends
  - Not recommended

Coleton's number  
is 2087211573

# 1/19/18 - Meeting 31

Friday, January 19, 2018 2:03 PM

- 11:00 - 12:30 Think tank rm 126 (same room as last time) for Tues. & Thurs. team meetings
- Design review (things to include)
  - Problem Statement
  - Last times suggestions (peoples input and how we responded)
  - Simple animation
  - Updated Budget
  - Have testing apparatus
    - We have a drum now (scrapped aluminum drum)
- Testing apparatus
  - Use bicycle breaks and don't put wheel on

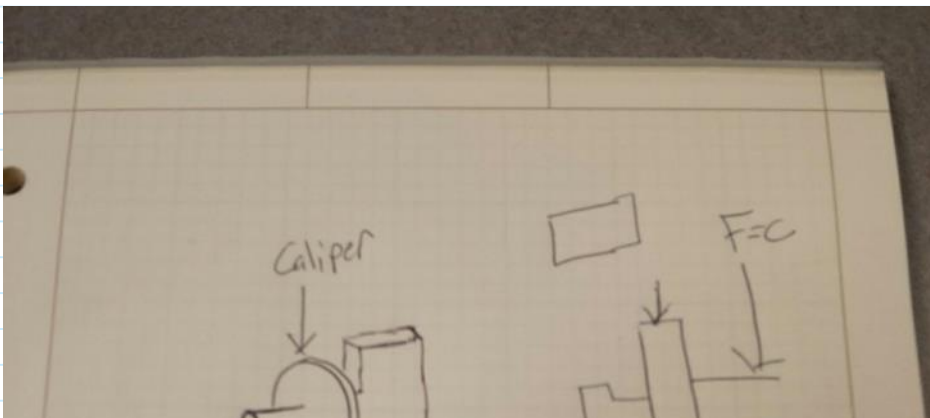
Notes on Animation:

Don't hide the back half,  
hide wheel

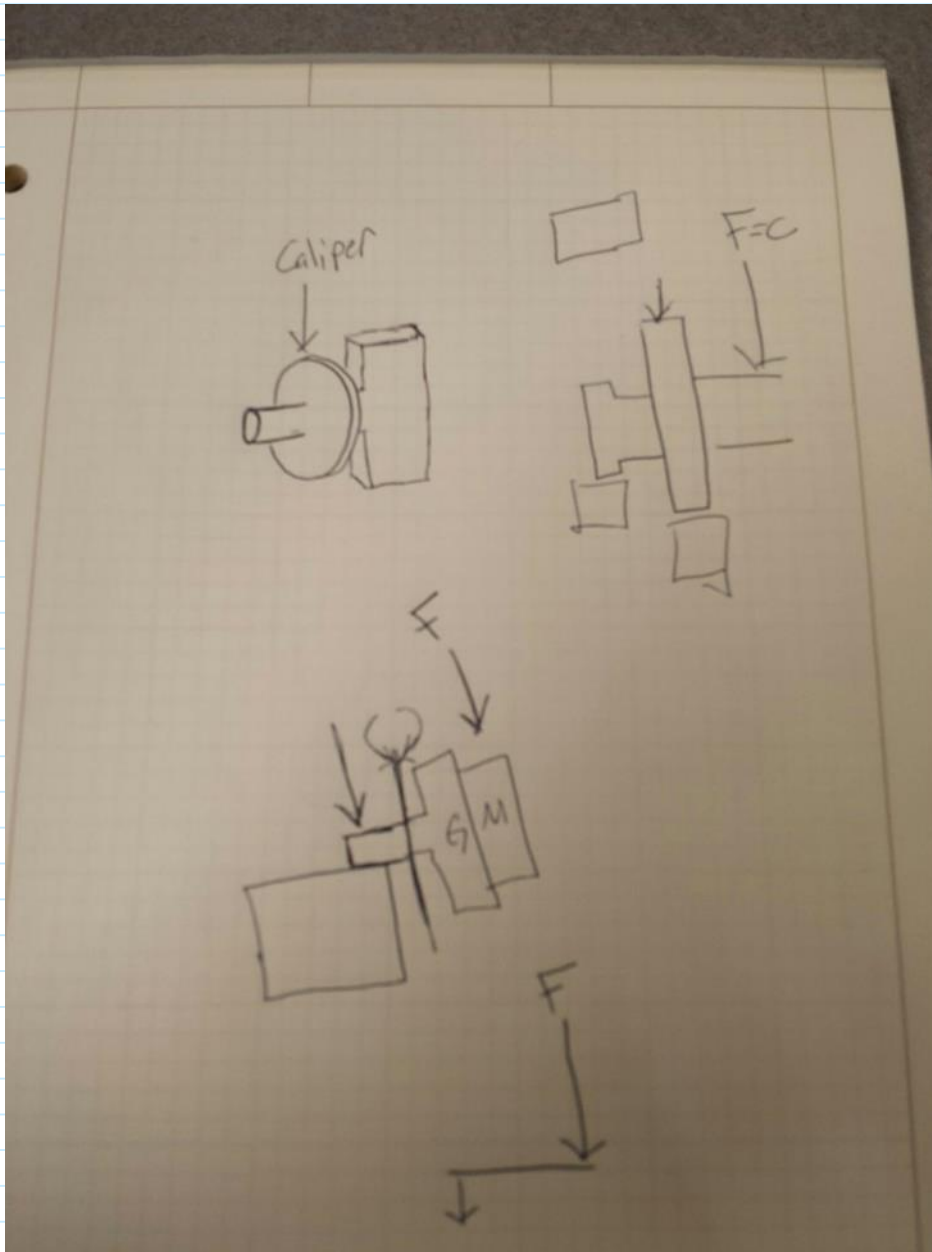
No camera rotation

Motor turning, gears moving

- Action Items
  - ✓ Gabe: Track down power supply, Document collision model
  - ✓ Gabe and Brad: Ask Billl about plexiglass for backplate
  - ✓ Figure out testing apparatus
    - Don't make wheel?
    - Use brake rotor from Daniel's old bike
  - ✓ Talk about wheel at next meeting
  - ✓ Get weight of gearbox using CAD estimation to compare with actual weight - Daniel due 1/22
  - ✓ Daniel: switch fasteners to 8/32" flathead holes for backplate
  - ✓ Model shelf for output seal into the CAD model
  - ✓ Cross section view for Gabe for collision model
  - ✓ Create animation for design review #2, due 2/1
  - ✓ Jacob: Register team for Design Expo
  - ✓ Jacob: Start making powerpoint (refer to Brad's text)
    - ✓ Include progress, questions, etc. here: [Design Review #2 Prep](#)







# 1/18/18 - Meeting 30

Thursday, January 18, 2018 11:01 AM

- Instructor Meeting
    - See if Hans and Swenson can do Thursdays?
  - Workshop
    - Solidcam orientation with Coleton: Friday (1/19/17) at ...
    - Split up into groups of two:
      - Daniel will not be completely available for part manufacturing
      - Gabe & Brad: Monday 9:30
      - Gabe & Jake: Wednesday 9:30
      - Brad & Jake: Friday 9:30
      - Order of machining: NLB-Carrier plate, backplate, LB-Carrier plate, Shaft, Frontplate
    - Priority parts: shaft, front & backplate
    - Order pin and seal next week
    - Hex screws are a size too big (recommended by Bill)
    - "Point man" = Brad: communicates with Coleton and head of quality of all parts being produced
    - Since motor front plate is already threaded, 8/32" flathead holes can be used on motor backplate
    - Need to figure out how to bend strain reliefs on motor
  - Simulation/testing
    - Back-drive gearbox? (without motor)
    - Use wall outlet for power?
  - Formal Design review
    - Testing ideas
      - Quantify
      - Accelerometer, Wheatstone strain gauges
      - How to measure gears?
    - Lots of pics
  - Action Items
    - ☒ Brad: communicate with Coleton for Solidcam walkthrough tomorrow
      - Time?
    - ☒ Daniel: switch fasteners to 8/32" flathead holes for backplate
    - ☒ Gabe: Track down power supply, Document collision model
    - ☒ Jacob: Ask Billl about plexiglass for backplate
    - ☒ Figure out testing apparatus
      - Don't make wheel?
      - Use break rotor from Daniel's old bike
- Old Action Items
- ☒ Submit Green sheet for approval by Dr. Swenson – Jake
  - ☒ Order billet metals, potentially 3 day shipping – Jake
  - ☒ Schedule formal design review with Bastian on 2/9, build as much as possible by then
  - ☒ Send resumes to Hans
  - ☒ Prepare for formal design review - ongoing
  - ☒ Investigate plexiglass/acrylic back-plate for discussion at next meeting - Brad
  - ☒ Schedule room for meeting in the think-tank - Daniel
  - ☒ Model shelf for output seal into the CAD model
  - ☒ Talk about wheel at next meeting
  - ☒ Inspect metals available in shop supply
  - ☒ Get weight of gearbox using CAD estimation to compare with actual weight - Daniel due 1/22

☒ Contact SDP for status of gears - Gabe

# 1/12/18 - Meeting 28

Friday, January 12, 2018 1:33 PM

## Action Items

- ✓ Talk with Bill Magnie about reserving a storage table/workspace in senior design suite
- ✓ Schedule Meeting with Bill to review part design and fabrication intent
  - ✓ Tuesday 1/16, 8:30-9:00 AM, check with Bill
- ✓ Order metals from Alcobra, potentially 3 day shipping, following meeting with Bill
- ✓ Schedule formal design review with Bastian by ~2/9, build as much as possible by then
- ✓ Meeting 2:00 on Sunday

Agenda:

### 1:30 – 1:45: Prototype 01 construction timeline

Construction Timeline:

- We only need one person in the shop at a time
  - Coleton only wants one machine running at a time
- Order stock materials
- Order 1 seal - talk with Brad and Gabe
- Gabe has the gears
- Carrier plates first
  - Each piece should take 1-2 days
- Shaft
  - Material hardness will determine machining time, minimum 2 days
  - Using the CNC lathe will go much faster
- Rear Housing
  - 2 days
- Front housing
  - 4 days
- Schedule sit down with Bill to review part design

### 1:45 – 1:50: Mentor meeting times

Coleton's availability: Morning hours are preferred, 8:30-9:30 start time until 1:30 for machining time, flexible with later times, but not preferred

### 1:50 – 1:55: Team/Instructor meeting times

- No go times:
- 3:30-5 MTWR
- Thursdays and Fridays work well
- Thursday 8-9:00? Check with Brad,
- Fridays work well, 2:00

### 1:55 – 2:00: Second semester goals

- Proto 1 completion
- Testing of proto 1

Potentially Proto 2?

And testing

**2:00 – 2:05: Q & A**

Money saved on motor was great

Be aggressive with timeline

# 12/13/2017 - Meeting 27

Wednesday, December 13, 2017 2:07 PM

## Comments on drawing package

We can work with Hans to negotiate a lower cost for the TG5153 motor, but that is dependent upon negotiation that hasn't happened yet. We could continue by being over budget, since other projects may potentially come in under budget

Dr. Swenson recommends that we do all fabrication and machining in-house, because:

- A) It gives us more fabrication control
- B) More revision control
- C) Going through the machining process is extremely educational and insight providing

# 12/8/2017 - Meeting 26

Friday, December 8, 2017 2:59 PM

## Budget

- Should not worry too much
- A couple hundred dollars over budget is not a big deal
- Budgeting the outsourced parts for machining should not be too difficult

## Gearbox

- It is desired that the flange is rounded on the top
  - Swenson would like to see more bolts on the flange
  - There should be a bolt at the bottom flange
- There needs to be a stop between bearings in neck on wheel side
- Drain Plug
  - Concerned that there isn't enough material for the tapped hole
    - Coleton thinks that the current wall thickness of tapped hole isn't ideal but doesn't suggest it
  - Smallest drain plugs are M8
  - Swenson believes that for prototyping purposes it looks good
  - Daniel said that thickening the face on the wheel side would allow more material strength
    - Swenson agreed
- Swenson doesn't think the bearing on the motor side is necessary and that a simple seal would be good enough
- Shaft Seal
  - Names: Radial Oil seal, Rotary seal, shaft seal
  - Simply need to add a lip to fix it
  - Swenson still doesn't think seals on bearing will be enough
  - Swenson doesn't want to push wheel side bearing in any further to make room to mount the shaft seal
  - Placing seal between wheel side bearings
  - Swenson is willing to put a seal between wheel side bearings
- Shaft
  - Swenson is worried that shaft is not fixed in place enough and that pressing the shaft into the bearings will not be enough to keep it from slipping out
  - A shaft pin should fix the shaft with ease. The only issue is sealing the pin whole. Swenson and Coleton both like the idea(Jake)
    - The pin should be placed vertically to decrease stress in the neck of the housing
- Carrier plate
  - Too close to inside of housing
- Bearings
  - Could inner bearing on wheel side be smaller than the outer bearing on wheel side
  - May not last the life of the vehicle
- In the big picture, Swenson is comfortable with the current design as a prototype
- Gears
  - Sun gear should be hardened but for prototyping it is unnecessary

## ☒ Order Parts

- ☒ Jake: Get the Green sheets
- ☒ Brad: Gears-SDP
  - ☒ Will ask about a hardened sun gear
- ☒ Daniel: Motor

## ☒ Finish CAD (Team)

- ☒ Daniel Email Hans about delay

# 12/4/2017 - Meeting 25

Monday, December 4, 2017 2:29 PM

- Write email to Swenson and Coleton to know if those deductions are fixed
    - Is shop fund correct?
      - Talk to molly to know if \$1450 for shop over head is correct?
    - Email contents:
      - Shop overhead: why do we have to pay combined amount of \$1024 for Coleton and also \$1450 for shop overhead? \$1450 sounds too high
  - We cannot meet our budget given our current "spending money"
- ☒ Jake meet with Molly
  - ☒ CAD All due 12/9
    - ☒ Move ring to front half
    - ☒ Bolt holes for mounting bracket
    - ☒ Drainplug and fill port
    - ☒ Seals
    - ☒ Bearings
    - ☒ Fasteners
    - ☒ PEMS
    - ☒ Snap ring for axle
    - ☒ Tolerance analysis
    - ☒ Drawings
  - ☒ Daniel Email Hans about ordering CNC parts following CAD completion



# 12/1/2017 - Meeting 24

Friday, December 1, 2017 12:23 PM

## Agenda:

### Motor:

- We need to purchase the TG5153 ASAP
  - 4 week turnaround according to Bastian quote
  - Need to contact Janelle Taylor (Paul Burgeson's contact at ThinGap)
- How do we setup the billing for this purchase?
  - Do we use a check, cash, or card?
  - How does it get billed?

### Gearbox:

- Hans is comfortable with us using their facility or CNC vendor to fabricate the gearbox since it means a faster turnaround for our prototype

### Gears:

- Currently selected gears:

### Budget: - Jake and Dr. Swenson will go over this later

- \$6000 total
  - Deduction for Coleton
  - Deduction for travel
  - Likely leaves \$4000 remaining for prototypes
  - Most hardware can be re-used from proto I to proto II

### Oil

- Chevron makes a nice oil for our operating range - Dr. Swenson
- We want our oil to be stirred but not foamed
- Too little oil it foams, goes from red to pink
  - Could overheat and not lubricate gears
- Too full, too much energy loss
  - Could be as much as 25% efficiency loss
- About halfway is a good starting point
  - Dependent on viscosity
- Plexiglass window idea is a good way to go
- Make the entire back plate out of plexiglass/Lexan
  - Talk with Bill Magnie about how to fabricate this piece
  - The piece made for Wagstaff hyrdo-electric look crystal clear - Coleton
- Temperature range consideration needs to be made
- Start with an off the shelf ubiquitous transmission oil for a car/dirt bike

### Seal:

- Laser cut neoprene/fabric gasket
- Grape-jelly liquid sealant? - best option for between the gearbox halves
  - Heat may break down other rubbers and seals
- Engine block style gasket
- Double lip seals for shaft/bearing output
  - Flanged double-sealed bearings may not be adequate

### Drain plug

- Magnetic, potentially from a dirt bike
- Where do we place this?
- How often do we need to change the oil?
- Can we find an oil with a 5 year life span?

### Motor Shield

Could be sheetmetal shroud

#### Gearbox Assembly:

How does it all assemble?

We should move the ring gear to the wheel side casing half

Mounting bracket

#### Test Design

We could use a 55 gallon drum sliced section on a large motor with bumps added in

Gives a consistent test analysis fairly easily

Drop items onto a spinning wheel

Could become a consistent test

Treadmill idea

Wagon wheel idea

All of these are better than

# 11/27/2017 - Meeting 22

Sunday, November 26, 2017 12:45 PM

## Action Items:

- ✓ **Poster Updates for snapshot complete ASAP:**
  - ✓ **Jake is redoing the problem statement page**
  - ✓ **Daniel is editing/creating the gearbox page**
    - ✓ **FEA Results**
    - ✓ **Design Challenges**
    - ✓ **Justifications for design**
  - ✓ **Brad will update gear analysis page**
  - ✓ **Gabe will update motor page and add thermal analysis**
  - ✓ **Daniel and Brad will update/create shaft/bearing analysis page**
- ✓ **Update Gantt Chart - Jake**
  - ✓ **This is located here** [Live Gantt Chart Page](#)
- ✓ **Email Hans for motor ordering - Daniel**
  - ✓ **Ask about gearbox fab**
  - ✓ **Ask about motor driver**

## Talking points:

1. Gantt chart
  - a. Snapshot #2, 12/1/2017
  - b. Order Motor, Tell Hans ASAP
    - i. 4-5 weeks shipping
    - ii. Motor Driver
  - c. Gears, 12/4/2017
    - i. 3 week shipping
    - ii. SDP
    - iii. 304ss 194BHN
  - d. Order misc., 12/11/2017
    - i. Bolts
    - ii. Bearings
    - iii. Dowls
    - iv. Billet material
    - v. Shaft stock
    - vi. Snap ring
    - vii. Wheel Traction
    - viii. PEM FH studs
  - e. January
    - i. Fab Gearbox (Mill)
      - 1) Before Break
    - ii. Fab 2 Shafts (Mill)
      - 1) Before Break
    - iii. Fab Carrier (Mill): 2-3 hr
    - iv. Fab Wheel (3D print as one part): 24 hr
    - v. Dynamic Testing
    - vi. Oil selection
      - 1) Dirt Bike Oil

Snapshot (Fri (Dec 1st 8:30-10:15)

Order Motor

- Print-outs
  - Visuals
  - Due Dates (Projected)

$\approx 4.5$  Lead time?

### Printouts

Problem  
Statement  
Deliverables  
Goals

Team Photo

OLD : NEW  
CAD : CAD  
I

Gantt  
Proto 1  
& BOM

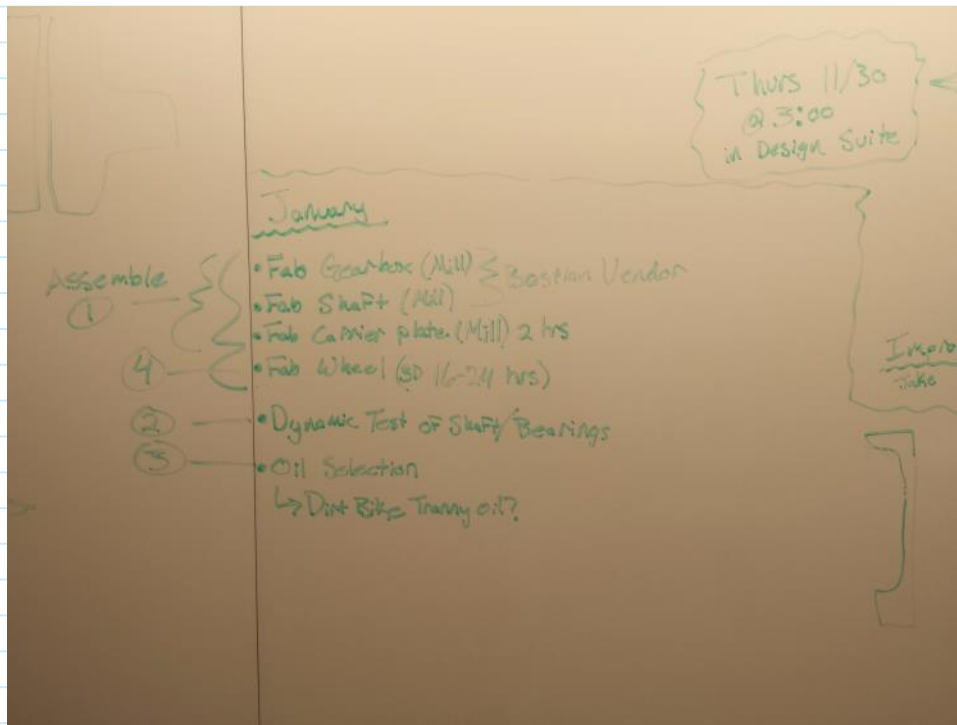
Motor  
Pretty Graph

Gearbox

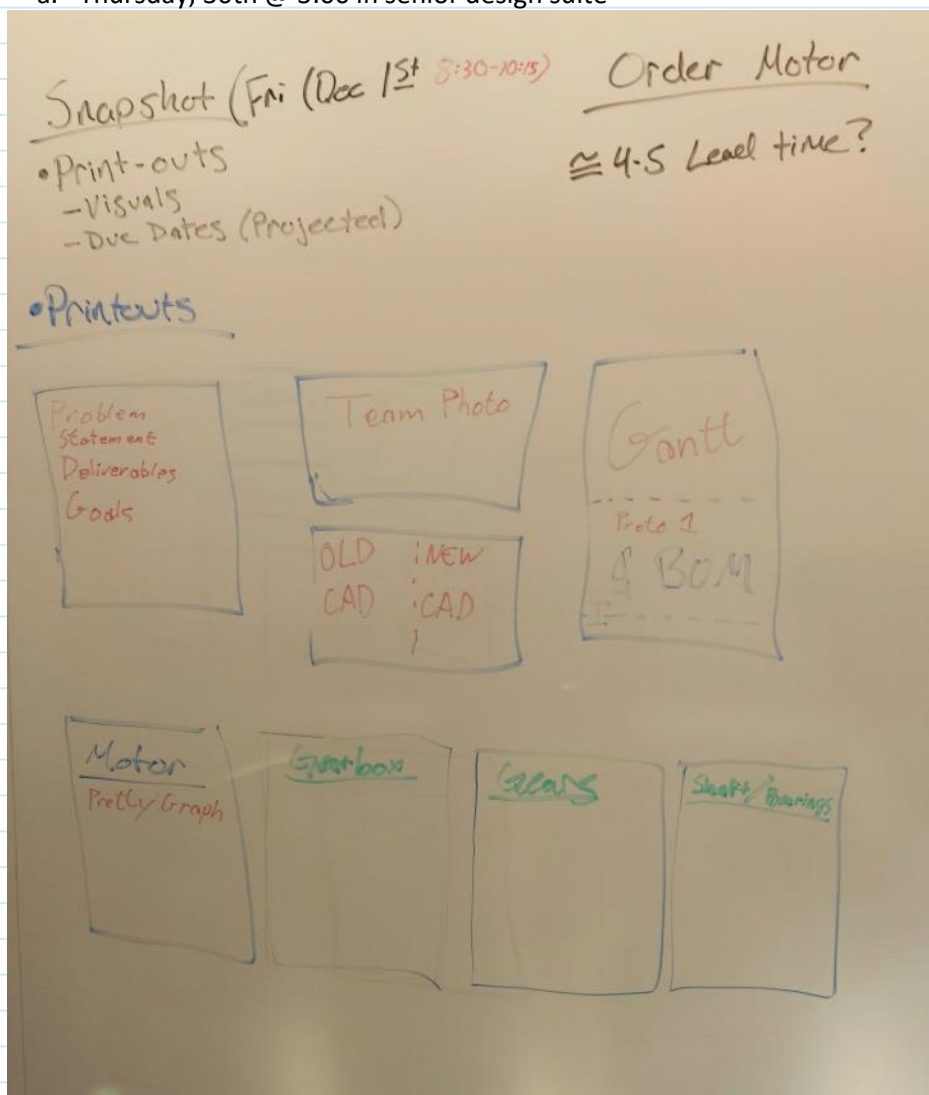
Gears

Shaft/Bearings

2.



- 3.
4. Snapshot day on Friday
- a. Thursday, 30th @ 3:00 in senior design suite





6. Proto build
7. Analysis of motor
8. Analysis of gears
9. Analysis of casing, carrier plate, and shaft
10. Analysis of bearings and impact loads
- 11.

12.



- Visuals
- Due Dates (Projected)

Team Hairs ASAP

## Printouts

Problem Statement  
Deliverables  
Goals

Team Photo

OLD : NEW  
CAD : CAD  
1

Gantt

Proto 1

8.13.11

Motor

Pretty Graph

Daniel

Spambox

Brad

Scars

Brad & Daniel

Shark's Bearings

# 11/15/2017 - Meeting 21

Wednesday, November 15, 2017 3:31 PM

Discussed impact loading on wheel and bearings from miscellaneous objects in facilities  
Discussed design review presentation as well, edited slides and talking points as seen fit, updated presentation attached below.

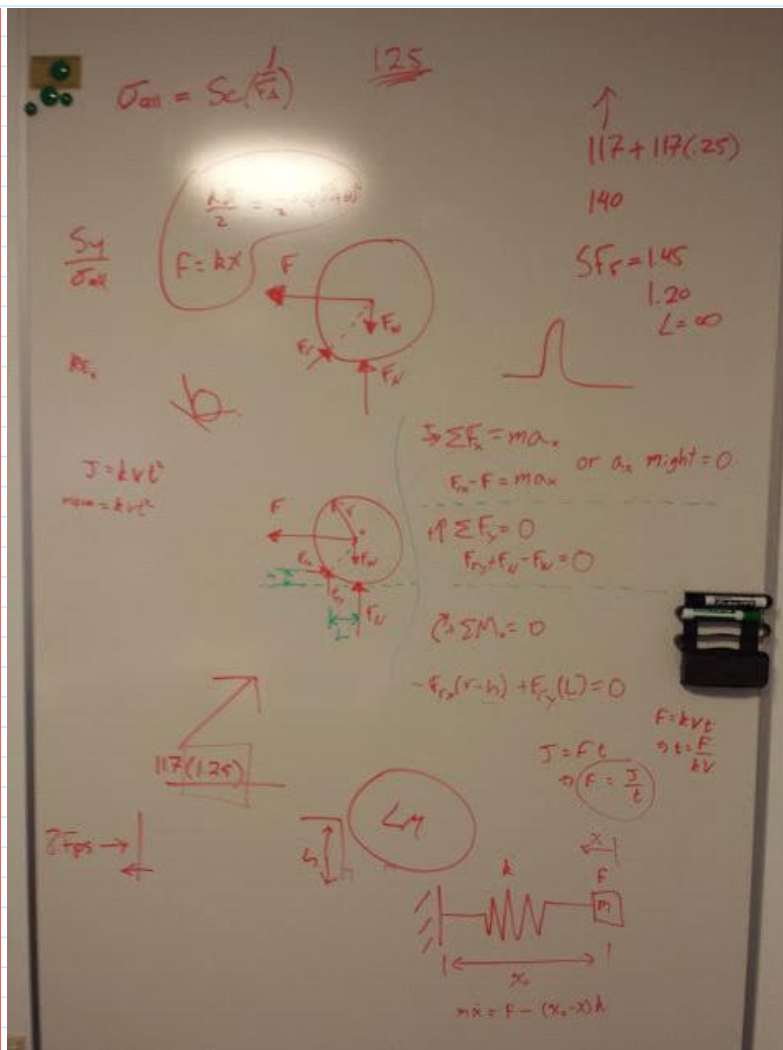


Design  
Review



This picture is incorrect, some of the equations are faulty, updated picture below





Updated picture, corrected equations - DRH 11/15/17, 3:52 PM

Questions moving forward:

Do we need a spring constant analysis for our wheel/motor/gearbox/bearing assembly?

What kind of force do we have in reality?

We can take our shaft and assume it absorbs all the deformation and establish a spring-factor for the shaft design as of now.

We don't know our wheel/shaft/frame/assembly/shuttle stiffness to do a proper dynamic and structural analysis

Major Decisions:

Damage from small impacts unlikely given current non-value analysis,

# 11/10/2017 - Meeting 20

Wednesday, November 15, 2017 8:26 PM

## Instructor/Mentor Meeting Agenda #20

**Date:** November 10, 2017

**Time:** 12:30 pm – 1:30 pm

**Location:** ME Conference Room

**Attendees:** Dr. Swenson, Daniel Hien, Jacob Riggs, Brad Morris, Gabe Riggs

**Objective:** To discuss the progress the team has made towards the project and whether we are on schedule and have the right trajectory. Schedule official dates for design review and discuss required Design Review Items.

### 12:30 – 12:40 Project Progress (10 min)

- Project Schedule/Goals

### 12:40 – 12:50 Schedule Design Review (10 min)

### 12:50 – 1:20 Design Review Items Discussion (30 min)

- Gears
- Commutator
- Assembly

### 1:20 – 1:25 Action Items

### 1:25 – 1:30 Round Up (Q & A)

# 11/8/2017 - Meeting #19

Wednesday, November 15, 2017 8:25 PM

## Meeting Minutes #19

**Date:** November 8, 2017

**Time:** 3:00 pm – 4:00 pm

**Location:** Library 1<sup>st</sup> Floor

**Attendees:** Daniel Hien, Jacob Riggs, Brad Morris, Gabe Riggs

### Objective:

#### 3:00 – 3:15 Project Progress (15 min)

- Brad will update Gantt Chart and we will discuss project progress for next meeting

#### 3:15 – 3:20 Schedule Design Review (5 min)

- **Other team design review**
  - 3:30 tomorrow, ME conference room
  - 2:00 Tuesday, ME conference room (next week)
- **Our design review (possibilities)**
  - 2:30, Wednesday (for next week)
  - 2:30, Thursday (for next week)
  - 11:30, Friday (for next week)
- **Deliverables**
  - Motor (Gabe)
    - Operating points
    - Thermal analysis
      - Duty cycle
    - Efficiency
    - Dynamic models (60 amp current limiter)
    - justifications
  - Gears (Brad)
    - Material analysis
      - Tk report with commenting
      - Torque
      - Fatigue
    - Justifications
    - Mention our analysis software
    - Dynamic analysis (Jacob)
    - Ratios justification (Jacob)
  - Gearbox Casing (Daniel)
    - Stress analysis
    - Fabrication
    - Bearings justification
  - Shaft (Brad)
    - Material
      - Fatigue/statitics
    - Size

- Production (Daniel)
- FEA (Daniel) \*only if there is time
- Insulator (Daniel)
- Drawings and ISO's (Daniel)
- Budget analysis (Daniel)
  - Single volume
- PowerPoint and Packet (Jacob)
  - Order: Motors, gears, gearbox-casing, bearings, shaft, budget, budget/production
  - Packet: safety factors, labels
- L-Bracket (Jacob) \*should be really simple

### **3:20 – 3:50 Design (30 min)**

- Gears
  - With shigley we have a safety factor of 3 with bending stress
  - Odom said that usually contact stress is the dictator. Much more complex
    - Daniel has some bookmarked pages on contact stress in share drive
- Motor
  - Need full updated analysis before meeting on Friday
- Commutator
  - Unsure why current design is so big
- Shaft
  - Deflection may be completely negligible
    - We will wait for Hans' opinion
- Assembly
  - Pins, bushings, Pems, Bolts

### **3:50 – 3:55 Action Items**

- Names in parentheses correlate to assigned action item
  - Get everything done by Saturday afternoon of this week

### **3:55 – 4:00 Round Up (Q & A)**

# 11/3/2017 - Meeting 18

Wednesday, November 15, 2017 8:25 PM

## Instructor/Mentor Meeting Minutes #18

**Date:** November 3, 2017

**Time:** 3:00 pm – 4:00 pm

**Location:** Senior Design Suite

**Attendees:** Dr. Swenson, Coleton Bailey, Daniel Hien, Jacob Riggs, Brad Morris, Gabe Riggs

**Objective:** To review and provide feedback on the Wiki-Draft. Discuss subsystem analysis and rate progress toward upcoming Design Review.

### 3:00 – 3:15 Wiki-Draft Review (15 min)

- Will figure out how to put motor selection pictures in
- Need to fix concepts on ke and kt
- May have gone too deep on the technical side. No need to go any further
- As long as we do not refer to Bastian's bigger picture we are fine
- Daniel where will send out draft to Hans

### 3:15 – 3:50 Subsystem Analysis (35 min)

- Gearbox
  - Load analysis is being considered at 6:1 ratio with sun driving and carrier as output
  - Load calculations are conservative and may be over estimate of max conditions
  - Gearbox allows for 0.5 inches of clearance
  - Carrier Plate
    - We shouldn't be too worried about the current design of the gearbox
  - Bearing is adding too much length
    - Based on shaft diameter
- Shaft
  - Modelled under 117 lb load
  - Daniel was curious about shock load
    - Should cause cyclic softening or hardening
  - Brad will do an analysis at the fillets as well
  - All safety factors for yielding are seeming to be satisfactory
  - Consider keyed shafts
    - Typically keys or splines are used
    - Construction of a step-down hex shaft would be easier
    - Using a set screw may not work
  - Dr. Swenson is not comfortable with free body diagram of shaft
    - One bearing will not make the load on the gears negligible and this is because of deflection of the shaft, Gearbox, and gears
    - Typically, two bearings are used
    - Perhaps a clam shell bracket would solve this issue and allow for two bearings
- Motor
  - Define worse case duty cycle
    - Find average power loss per cycle

- Assume thermal conductivity from motor housing and use air gap as insulator

### 3:50 – 3:55 Action Items

Same as last meeting

Name	Action Item	Due date
Daniel		
Brad		
Brad		
Jake		

### 3:55 – 4:00 Round Up (Q & A)

# 10/30/2017 - Meeting 17, long update

Wednesday, November 15, 2017 8:24 PM

## **Basti Boys group status and roadblocks:**

Pressing deadlines as of : 10/30/2017

Jake Daniel Brad Gabe

### **Design review due by 11/17 at the latest**

- Requires meeting with Hans and Swenson for review
- Ideally we should schedule to sit in on other team's reviews prior to our own
- We should have a full CAD mockup done prior to review and internally reviewed prior to formal review
- Cost analysis should be done for this
- Stress and fatigue analysis should be done for this
- Motor analysis should be complete for this (electrical, thermal, cost, etc.)
- Shaft stress and fatigue analysis should be done
- Spatial analysis needs completed
- Hardware selection and analysis complete (bearings, bushings, bolts, etc)
- Gearbox fatigue and stress analysis should be done
- Hinges on:
  - o CAD mockup and drawings
  - o Stress analysis
  - o Cost analysis
  - o Motor Analysis
  - o Spatial analysis
  - o Mounting analysis/design
  - o Etc.

Wikipage deliverables – Jake is handling this, due 11/3/2017

Needs: Screen shots of models – Jake will gather these

Bio for each person, talking about who we are

Four sentences – hobby, major, picture, graduation date, favorite color, favorite aspect of project

Mission/goals statement – Does Jake have this covered?

Logbook and portfolio review – 11/7/2017 – does Jake need help with portfolio prep?

## **Background:**

Previous solution

Dimensions

Power consumption

Cost

Previous specs

## **Specifications**

List of requirements and limitations

Analysis – Each person send Jake about 1 page for everything, and 1 picture per designed idea with their name on it by Noon on Thursday 11/2/2017

Motor Selection

Dimensional Analysis - Daniel  
Mechanical Power Analysis - Jake  
Electrical Power Analysis - Gabe  
Thermal Analysis - Gabe

## Gearbox design and analysis

Gear design and selection – explain cost - Jake

Material Analysis - Brad  
Loading Analysis - Brad

### Casing design

Spatial Analysis - Daniel  
Thermal Analysis - Daniel  
Manufacturability Analysis - Daniel

### Carrier Plate Design

Loading Analysis - Jake  
Fatigue Analysis - Daniel  
Material Analysis - Daniel  
Manufacturability Analysis - Daniel

## Shaft design and analysis

Material Analysis - Brad  
Stress Analysis - Brad  
Fatigue Analysis - Brad

## Project Learning

Research summation, 2 paragraphs by Christmas, 1 paragraph for initial release

Shaft Fatigue and lifecycle analysis program – Brad has this handled

Will deliver: min shaft diameter needed for infinite life span given:

Load locations  
Load amounts  
Material choice (referencing shigley for HB, young's etc.)  
Variable bearing axial thickness  
spread sheet completed for multiple diameters and materials - 10/30

Needed – Stress concentration addition to TK solver program to evaluate accuracy of results

- Verify with CAD FEA
- Can we re-use their flange mounted shaft idea?
  - o Insulating flange bushings between axle mount and gearbox

TK program review:

Ignoring notch analysis at the carrier plate end to simplify modeling and analysis  
-Majority of fatigue is due to bend from the bearing to the climbing pinion  
Analyzed four different materials with different heat treatments  
Multiple diameters with each material  
Static Yield strength is negligible for safety factor  
Bigger diameter is better  
Quenched and tempered steel is required, hot and cold rolled steel is just not an option

Mated flange/shaft idea review

Mated plates with insulator gasket and insulating bushing and bolts between flange  
Brad will analyze over the weekend per discussion in meeting



## Motor – Beginning thermal analysis – Gabe

We may need a different motor based off of RMS vs continuous voltage differences in calculations – more to follow from Gabe

Gabe has created a matlab program to roughly determine heat waste energy from motor and will deliver spreadsheet of thermal energy output at various voltage and amperage levels

We need to develop a thermal characterization of the motor at some point to accurately simulate our thermal situation and create heat management solutions

Thermal analysis started and spreadsheet generated

Mechanical power analysis complete

Electrical power analysis complete – will update with included damping coefficients

We will need a cooling fan in the final design iteration

Our thermal situation may not be that bad?

### Thermal situation for TG5153 Motor

@ 8ft/s, 4 Nm, 580 W generation, 44.64 Volts, 5.16 Amps

RMS knowledge indicated that this is overkill conclusion for thermal situation.

## Gearbox –

Materials and stress analysis for gear – Brad will verify coding with Odom

- Do we simply triple our contact ratio? Or can we triple our rated torque on the sun gear given that we have 3 planets? or something else?

Odom is non-responsive but considering obtaining gear optimization software

We need a stress analysis for the planet gears, not nearly as crucial though- low priority for this semester

Brad is thinking about this – can adapt current program to calculate the fatigue of the planet gears without much work other than adding in the contact from the ring gear

Bushings will leave a considerable financial dent regardless of approach... we may go without for first proto.

Pins, shoulder bolts, standoffs, bushings etc. for carrier/planet interface

Carrier –

Daniel has started FEA analysis will contact Dr. Maughan for confirmation of approach

Required backlash – ask Hans – low priority

Full CAD workup/designs and drawings --- Invite Odom after this

Must be machinable – stick with inch dimensions when possible

Avoid stress concentration points in carrier and bearing locations

Complete stress analysis of carrier plate

Order gears from SDP/QTC -- We will order these this week if Brad's analysis is verified by Odom.

Will these work with plain steel for a proto? Current worst case safety factor is 1.1 for prototype with soft steel

Information from Indianapolis engineer – Daniel is responsible for this

- Torque/RPM curve for specific voltages – compare against Gabe's spreadsheets
- Cost and lead time
- CAD model
- Mounting information
- Bearing information (TG5153)

### **Basti-Boys Capstone end goals/deliverables**

Overarching: system operating life of 5 years at worst case + safety factor

- System cost at high volume <\$2000

- Voltage draw limit of 48V

- Current draw limit of 60 Amps

- Drafts, CAD, simulations, analysis, documentation

- Axial length from motor butt to wheel edge of 4.4"

- Rated torque output of 20 Nm

- Rated weight load of 142 lbs

End goals for each system:

Motor:

- Accurate thermal simulation for varying situations

- Accurate power draw calculations for corresponding T, V, I, etc.

- Accurate knowledge of torque scenarios

- Accurate knowledge of dynamic response

Gearbox: - Cost minimized, axial length constrained

- Thermal

  - simulation and heat management solution identified

  - Rated operating temperature

- Bearings

  - specified for economic value and fatigue analysis

  - Sealed against dirt/dust/ingress

- Gears

  - Safety factor calculated

  - AGMA/ISO factor stated

  - Backlash allowable known and met

  - Full documentation of assumptions and analysis

- Carrier plate

  - Cost is minimized

  - Designed for infinite life

- Box

  - Low cost

  - Potential for die-casting/high production solution

  - Conductivity/electro-pitting minimized by axle solution

Shaft/Axle

- Routes charging power from electrified pinion/rail to the commutator and prevents electro-pitting of bearings, gearbox, and motor

- Infinite life-cycle

- Minimized cost/complexity

Commutator

# 10/27/2017 - Meeting 16

Wednesday, November 15, 2017 8:17 PM

## Meeting Minutes #16

**Date:** October 27, 2017

**Time:** 3:00 pm – 4:00 pm

**Location:** Senior Design Suite

**Attendees:** Dr. Swenson, Daniel Hien, Jacob Riggs, Brad Morris, Gabe Riggs

**Objective:** To discuss minutes from client meeting. Present design drafts to Instructor and Mentor. Discuss items for Design Review.

### 3:00 – 3:10 Client Meeting Debrief (10min)

- Found a TG5153 motor that will need a 6:1
- Guy in Indy will get a quote for at volume from TG. Single volume cost is \$1900.
- Hans did not like the stacked KBM Framo idea because Framo has long lead time. KBM motors will still work with Hans.
- We were told of a new gear provider other than Rush gear. The needed gear box would be around \$350.
- Prototype motor is off the table.
- Sooner the better with a prototype. Does not have to have the final product materials.
- Hans will look into a power supply for us

### 3:10 – 3:30 Design Drafts (20min)

- The current drafts using framo are no longer relevant.
- We are now going only with the TG
  - Need to start a CAD model
- Gearbox should have oil input and drain plugs. Drain plug should be magnetic to catch metal filings. We can put fins on the gearbox.
- Finish a model layout for next week

### 3:30 – 3:50 Design Review (20min)

- Will discuss next week

### Other

- Come Sunday at 5:30 to GJ to finish model layout

### 3:50 – 3:55 Action Items (5min)

Name	Action Item	Due Date
Brad	<ul style="list-style-type: none"><li>• Update Gantt Chart</li><li>• Gear Analysis</li></ul>	Next meeting
Jacob	<ul style="list-style-type: none"><li>• Update Shared drive</li><li>• Rename files</li><li>• Flatten file structure</li><li>• Work on wiki</li></ul>	Next meeting

<b>Daniel</b>	• CAD	Next meeting
<b>Gabe</b>	• Efficiency approximation and analysis of TG5153 motor and thermal approximations	Next meeting

# 10/25/2017 - Meeting 15

Wednesday, November 15, 2017 8:16 PM

## Team Meeting Minutes #15

**Date:** October 25, 2017

**Time:** 3:00 pm – 4:00 pm

**Location:** Library 1<sup>st</sup> floor

**Attendees:** Daniel Hien, Jacob Riggs, Brad Morris, Gabe Riggs

**Objective:** To debrief on Wiki Page. Update and review portfolio for upcoming Portfolio Review. Discuss action points from client email and decide what actions to take regarding proposed air-gapless motor. Make sure that Design Drafts are presentable for Dr. Swenson for Friday meeting.

### 3:00 – 3:05 Wiki-Page (5min)

- Jake will make a general layout and will run it by the team for peer review.
  - Wikipage title: Industrial robot wheel drive design

### 3:05 – 3:10 Portfolio Review (5min)

- Design drafts
- Excel sheet with selected motors
- Optimal Gear ratio table (May not need anymore)
- Add justifications for current
  - Math models
  - Optimal gear ratios
  - Selected motors and Design

### 3:10 – 3:40 Client Email Discussion (30min)

- Schedule Client Meeting
  - Tomorrow at 11:00 AM (tentative)
- Air-gapless motor
  - Go through sheet and calc specs
  - Can we buy it? Is it offered? How many per year? Cost? Size?

### 3:40 – 3:50 Design Drafts (10min)

- Cross section (right plane)
- Isometric view
- Exploded View
- Very brief conceptual design summary

**3:50 – 3:55 Action Items (5min)**

<b>Name</b>	<b>Item</b>	<b>Due Date</b>
<b>Brad</b>	• Provide design draft elements for Thin Gap concept	Thursday 26 <sup>th</sup> by 11:00AM (tentative)
<b>Daniel</b>	• Provide design draft elements for KBM Motor	Thursday 26 <sup>th</sup> by 11:00AM (tentative)
<b>Jake</b>	• Email framo	Thursday 26 <sup>th</sup>
	• Create wiki-draft	Monday 30 <sup>th</sup>
<b>Gabe</b>	• Approximate Specs for air gapless motor • Email meetings and minutes	Thursday 26 <sup>th</sup> by 11:00AM (tentative)

# 10/20/2017 - Meeting 14

Wednesday, November 15, 2017 8:16 PM

## Meeting Minutes #14

**Date:** October 20, 2017

**Time:** 3:00 pm – 4:00 pm

**Location:** Library 1<sup>st</sup> floor

**Attendees:** Daniel Hien, Jacob Riggs, Brad Morris, Gabe Riggs

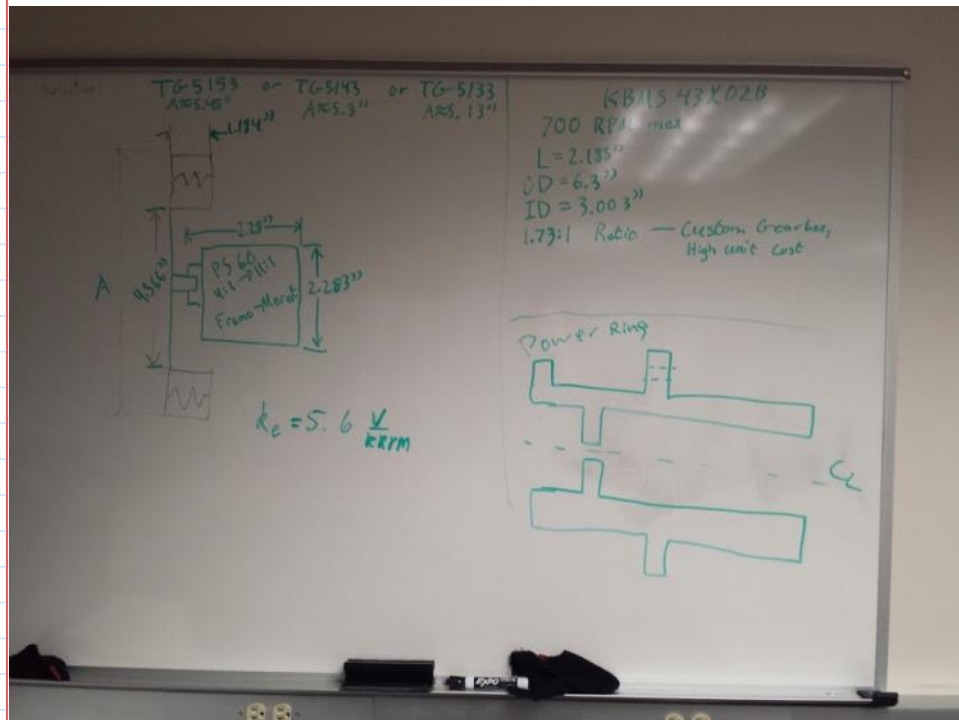
**Objective:** To select two motors from Kollmorgen that meet our design requirements. Develop two prototype designs using the selected motors.

### 3:00 – 3:20 Kollmorgen Motor

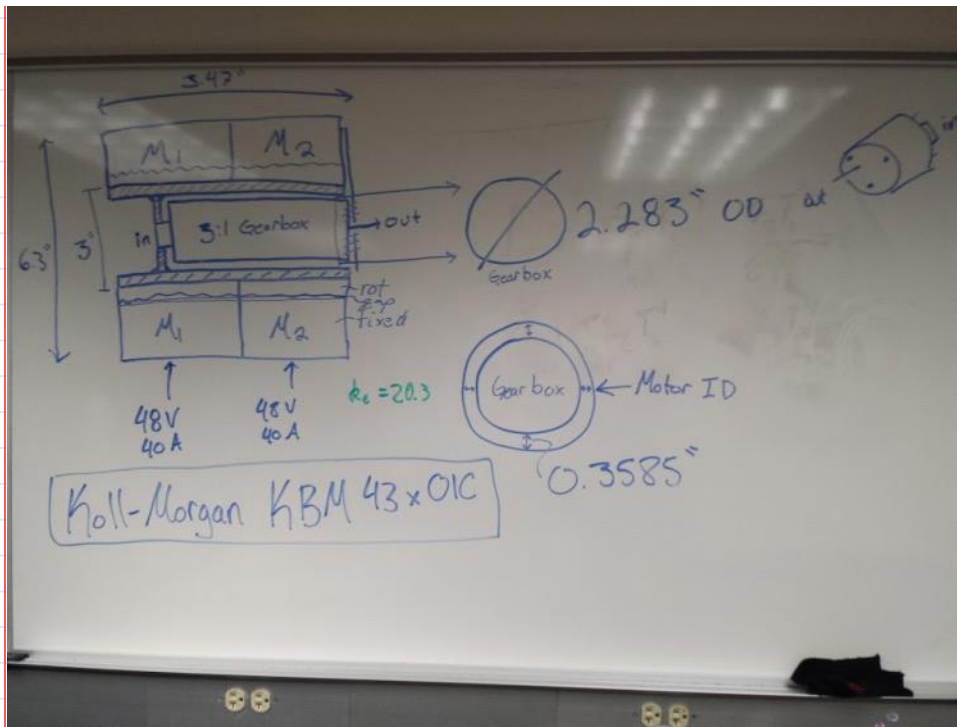
- KBM43S01C will work if stacked
- Thin Gap TG5153 will work without being stacked and at various ratios
- KBM43X02B will work without being stacked but only if run at 700 RPM

### 3:20 – 3:50 Gearbox and Motor Combo Design for selected motors

- Will use framo gearboxes for all motors selections



TG5153 + Framo-Morat Concept



Stacked KBMS43X01C concept



# 10/18/2017 - Meeting 13

Wednesday, November 15, 2017 8:15 PM

## Meeting Minutes #13

**Date:** October 18, 2017

**Time:** 3:00 pm – 4:20 pm

**Location:** Library

**Attendees:** Daniel Hein, Jacob Riggs, Brad Morris, Gabe Riggs

**Objective:** To develop general outline for wiki page. Discuss pitch competition. Discuss progress in motor selections and gear pricing/design.

### 3:00 – 3:10 Wiki Page

- Need to run by draft for hans.
- Copy an existing source if you like its format (less work)
- Cannot delete wiki page once created, so pass by Dr. Swenson before publishing
- Don't need to put information protected under NDA

### 3:10 – 3:20 Pitch Competition

- Not eligible

### 3:20 – 3:50 Design

- Motor Spread Sheet Calculator Findings
  - We need to make sure to not stack safety factors
- Gears
  - Pricing from Rush Gear
    - Daniel is looking up other ways to produce gears
      - Ring gears are ground, hobbled, wire edm, or broached
        - EDM allows best price and strength
          - A lot of vendors for EDM
      - Brad emailed Odom about gears, waiting for response
  - Alternative Vendors
    - Found around 8 vendors for EDM
      - Daniel will email them

### 3:50 – 3:55 Action Items

Brad: Meeting with Odom about gear life and company that can help us

Daniel: update on gear vendors and gear prices

Jacob: Wiki-page

Gabe: Update motor power calculator spreadsheet and input KBM stats

Everyone: email Gabe about topics to discuss with Dr. Swenson for next mentor meeting

# 10/16/2017 - Meeting 12

Wednesday, November 15, 2017 8:14 PM

## Meeting Minutes #12

- Required Brinell hardness for 6.51 ratio may be too expensive
  - We need 80ksi for yield strength to meet all gearbox strength requirements
  - We can double up the gears to meet our material strength needs
    - We can use Stainless steel as our material if we double
- Ask PMW if they can hit motor req. with 6.54 ratio or no ratios for our needs
- If we used a CVT then it would need to be custom to meet the needs
  - Perhaps a bicycle gearbox might meet size requirements
- Need motor with max power efficiency at worst case power need scenario
- \$2000 for first motor purchase
  - What is cost without motor brake
- Gearbox \$1000
- Will talk about wikipage for the Wednesday meeting

### Action Items:

Daniel will contact Hans about meeting time and Thin Gap for Wednesday or Friday

Jacob reserve room for Friday

# 10/13/2017 - Meeting 11

Wednesday, November 15, 2017 8:14 PM

## Meeting Minutes #11

**Date:** October 13, 2017

**Time:** 3:00 pm – 4:00 pm

**Location:** Senior Design Suite

**Attendees:** Daniel Hien, Jacob Riggs, Brad Morris, Coleton Bailey, Dr. Swenson, Gabe Riggs

**Objective:** To discuss next course of action for PMW motor. Discuss possible gearbox solutions and finalize at least three design solutions.

### 3:00 – 3:10 PMW Discussion

- Questions
  - Motor break
  - Encoder resolution
  - Constrain one or the other for dimensions.
    - Give them max diameter

### 3:10 – 3:50 Design

- Gearbox fatigue analysis and ratios
  - May need two stage gearbox
  - Should compare produced values with Rush Gear
  - Does direction of rotation and loading change expected life.
  - Ratio=6.54 pitch=26 s=22 p=59 r=144 , **ratio=5.36 (may not be symmetric) pitch=24 s=22 r=96 p=37**, ratio=6.818 pitch=32 s=22 p=53 r=128
  - Driving sun outputting carrier
- We need to be more iterative with the motor and gear selection.

### 3:50 – 3:55 Action Items

Name	Action Item	Date Due
Jacob	• Feedback • Update Torque and speed table	
Brad	• Feedback	
Daniel	• Feedback • CAD for gears • Email Hans about thin gap	monday
Coleton	• Laser cut gears (wood)	Wedsnday
Gabe	• Contact motors	

### 3:55 – 4:00 Round Up (Q & A)

- **Monday 23rd 3:00 meet with Swenson, missing Friday meeting**

# 10/11/2017 - Meeting 10

Wednesday, November 15, 2017 8:13 PM

## Meeting Minutes #10

**Date:** October 11, 2017

**Time:** 3:00 pm – 4:00 pm

**Location:** Library

**Attendees:** Daniel Hien, Jacob Riggs, Brad Morris, Gabe Riggs

**Objective:** To review and clarify roles and expectations of members and team. Update Shared Drive. Begin design process.

### 3:00 – 3:10 Team Member Design and Research Role Review.

- Need to communicate more.

### 3:10 – 3:20 Update Shared Drive.

- Jake will organize the shared drive.
- Daniel will make sure to provide renders or snip clip of each CAD model for reference.

### 3:20 – 3:50 Design.

- Gearbox
  - Number of gear teeth should be in prime numbers.
  - p 61, s 22, r 144
    - Fixed planets, Sun is the drive.
    - Ring is 6.75"
    - Allows for larger sun gear.
  - Jake emailed hyperlink to team. Contained stress equation for gears.
  - Fixing the sun gear limits possible gear ratios.
  - Ratios do not have to be whole numbers.
    - Rush Gear can provide large array of gears.
  - Increasing the pitch causes smoother rotation but decreases load capacity.
    - Also decreases axel bore diameter of sun gear.
- Add protective covering to motor and gearbox.

### 3:50 – 3:55 Action Items.

Name	Action Item	Date
Daniel	• Develop a table of number of teeth and gear ratio given a fixed state.	Oct. 13
Brad	• Provide comprehensive gear tooth analysis equations	Oct. 13
Jacob	• Organize shared drive • Develop general table of number of gear teeth, ratios, and diameters for different fixed states.	Oct. 13
Gabe	• Contact Printed Motor Works and Thin Gap	Oct. 13

10/6/2017 - Meeting 9

Wednesday, November 15, 2017 8:13 PM

## Meeting Minutes #9

**Date:** October 6, 2017

**Time:** 3:00 pm – 4:00 pm

**Location:** Senior Design Suite

**Attendees:** Daniel Hien, Jacob Riggs, Brad Morris, Gabe Riggs, Dr. Swenson, Coleton Bailey

**Objective:** To debrief on yesterday's client meeting and inform Instructor and mentor of minutes. To present and discuss updated Project Design Plan. Acquire input on planned Snapshot Day #1 poster board design.

**3:00 – 3:05 Action Item Review.**

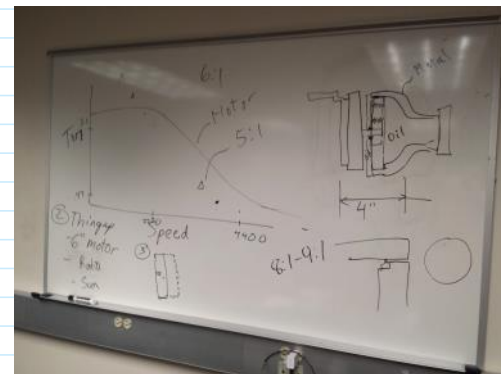
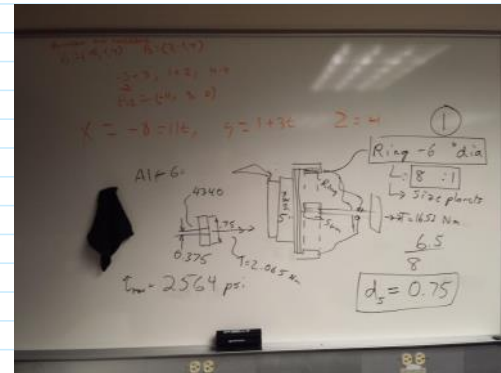
*\*Was not discussed.*

**3:05 – 3:20 Client Meeting Debrief.**

- Informed Instructor of Client meeting through summary.

**3:20 – 3:40 Project Design Plan.**

- Design Procedure sounds like a good plan.
- Motor Selection
  - Need to do far more analysis before communicating to a motor provider.
  - Find motor that produces max continuous torque curve that fits scaled maximum torque and rpm values.
  - Should submit motor specifications in terms of scaled ranges (scaled by gear ratio).
  - Talk to Thin Gap about a 6" motor (Custom).
- Gear Selection
  - Avoiding high ratio should be avoided.
  - Ring Gear should be no larger than 6.5"
  - Sun gear should be larger than 0.8125"
- Shaft needs to have a diameter that can withstand torque.
  - Make sure that sun gear diameter doesn't clash with needed shaft diameter.



**3:40 – 3:50 Snapshot Day #1 Plan.**

- Font 28 is optimal.
- More pictures and less words.
- Sketches of concepts would be great.
- Two people at the stand at a minimum.
- Feel free to send them out image of finished product to Dr. Swenson

**3:50 – 3:55 Action Items.**

*\*Same as yesterday's meeting.*

# 10/5/2017 - Meeting 8

Wednesday, November 15, 2017 8:12 PM

## Meeting Minutes #8

**Date:** October 5, 2017

**Time:** 3:00 pm – 4:05 pm

**Location:** Clearwater Room, TLC

**Attendees:** Daniel Hien, Jacob Riggs, Brad Morris, Gabe Riggs

**Objective:** To debrief on project progress and review the scope of the project. Share knowledge of resources and service providers. Prepare for Snapshot Day #1.

### Client Meeting:

#### Hans Leidenfrost –

- Not opposed to using motors in series.
- Not opposed to custom gearbox inside of ThinGap motor.
- It is dangerous to wait and its dangerous to go to early when it comes to ordering parts.
- Desires that team provides CAD drawings before ordering parts.

### Client Resources and Networking.

- Client purchased their epicyclic gears from Nugert (not sure if this is correct spelling).
  - Client purchased 4:1 single stage for current design.
- Boston gears do stock and custom gears.
- Rush Gear, Misumi, KHK, Stock Drive, and McMaster all can provide custom gearing.

### Other.

- Design Expo.
  - Have full assembly prototype that can demonstrate speed control and lift heavy weights.
- Snapshot Day #2.
  - Let Bastian see poster board items first before finalizing item choice.

### Team Meeting:

#### Snapshot Day #1.

- Developed poster board layout.
- Assigned roles to members.
- Will meet on Monday at 3:00 pm to construct board.
  - Each member will provide the necessary deliverables as assigned.

### 4:00 – 4:05 Action Items.

Name	Item	Due Date
Daniel	• Edit and format poster board	10/9
	• Email Bastian minutes	
	• Provide assembly sketch through CAD	
Gabe	• Provide motor info. for poster board	10/9
	• Get price quote from Thin Gap	10/12
	• Get lead time for order	
Brad	• Provide updated Gantt Chart for Poster Board.	10/9
	• Provide bearing info. for Poster Board.	
Jacob	• Provide Epicyclic gear info. for poster board	10/9
	• Choose epicyclic gear	10/19

# 9/29/2017 - Meeting 7

Wednesday, November 15, 2017 8:12 PM

## Minutes 7

**Date:** September 29, 2017

**Time:** 3:00 pm – 3:40 pm

**Location:** Senior Design Suite

**Attendees:** Daniel Hien, Jacob Riggs, Brad Morris, Gabe Riggs, Dr. Swenson, Coleton Bailey, Dr. Odom

**Objective:** To evaluate status of team portfolio. Discuss in detail the components and deliverables of Snapshot Day 1. Begin planning design process in detail.

### 3:00 – 3:05 Portfolio Review.

- Minutes can be put in either order (earliest to latest or vice versa)
- Excellent. Keep it up. Doing fine.

### 3:05 – 3:15 Snapshot Day.

- Must be condensed to one board (cannot be the originally selected threefold).
- Bottom half.
  - Gearbox, motor, commutator, bearings
- Put design requirements on chart.

### 3:15 – 3:30 Design Plan.

- Math Model
  - Tapered bearing may be more expensive.
    - It is okay to use online calculators.
    - Inputs may be too excessive.

### 3:30 – 3:35 Action Items. (Instructor and Mentor may leave at 3:30)

Name	Action	Due Date
Daniel	• Will contact Hans about meeting times	Next Wednesday
Gabe	• Find more motor providers. • Contact thin Gap. • Koll-Morgan.	Next Wednesday
Jacob	• Organize Portfolio	Next Monday
Brad	• Will provide FBD for torque needs. • Bearings. • Text about team picture.	Next Wednesday
Dr. Swenson	• Client meeting costs	As soon as possible

### Other.

- Gears.
  - Use Kiss program.



- Will provide information that will allow proper selection of gear.
- Charge per hours of use.
- Must have as much information as possible to get good results.
  - May be considering a custom gear set or something else custom.
  - Tighter the tolerance for backlash the more it costs.
- Lynch motors is very educational for brushless electric motor graphs.
- Iteratively fix motor or gearbox to select proper motor-gear pair.
- Need to calculate peak torque needs.
- 5:00 for team picture.

# 9/27/2017 - Meeting 6

Wednesday, November 15, 2017 8:11 PM

## Minutes 6

**Date:** September 27, 2017

**Time:** 3:00 pm – 4:10 pm

**Location:** Library

**Attendees:** Daniel Hien, Jacob Riggs, Brad Morris, Gabe Riggs

**Objective:** To brainstorm questions of unknown project specifications and range of project scope. Discuss upcoming items on Project schedule and plans to finish them on time. Present current math models.

### 3:00 – 3:20 Questions for Client.

- Vague Specs.
  - What are the exact maximum accelerations and velocities (vertical and horizontal).
    - On rack, off rack.
  - What is final ideal weight.
  - Could we have new more comprehensive Spec. sheet?

### 3:20 – 3:30 Portfolio Review.

- Need to use two pages for Gantt Chart.
- Update meetings.
- Need to put in upcoming Data sheets.
  - Snip clips of existing CAD. Just wheel drive.
- Team Picture.
- Client transcript.
  - Create new section called “Client Correspondence”.
  - Includes all communications.

### 3:30 – 3:40 Snapshot Day.

- Poster board.
  - Individual Research
  - Gantt Chart
  - Should use threefold

### 3:40 – 4:00 Present Math Models. (Can be a draft)

- Brad created tk program that replicates forces on bearings
  - Utilized SKF bearing calculator to select bearings based on tk simulations
  - Conclusion: roller taper bearings
  - Unknowns: operating temp, bearing grease type
- Jacob derived universal equation for single stage planetary gear set
  - Allows size comprehension of gear set
  - Only need size of annulus gear and sun gear
  - Developed program capable of outputting desired gear ratios
- Daniel worked on developing static calculations.

#### **4:00 – 4:05 Action Items.**

- Jake: portfolio
- Daniel: email Hans for clarification questions above and that we will consider a new wheel, CAD snipclip
- Gabe: Agenda
- Everyone:
  - condense research
    - references and description
    - math model basics

#### **4:05 – 4:10 Round Up (Q & A).**

##### **Other.**

- Will buy new wheel if we have time.
- Brad reserved room for next week meeting.
- Thin Gap provides flat motors.
- Brad will contact friend to take team picture.
- Should continue conversation on snapshot day 1 after client meeting on Friday.

# 9/22/2017 - Meeting 5

Wednesday, November 15, 2017 8:10 PM

## Minutes 5

**Date:** September 22, 2017

**Time:** 3:00 pm – 3:35 pm

**Location:** Senior Design Suite

**Attendees:** Daniel Hien, Jacob Riggs, Brad Morris, Gabe Riggs, Dr. Swenson, Colton Bailey

**Objective:** To assess current project progress and determine if team is on schedule. Debrief on client meeting with Instructor and Mentor. Discuss project design.

### 3:00 – 3:10 Client Meeting Debrief

- Discussed lack of shuttle weight provided by client specification sheet.
- 230 lb per wheel (Dr. Swenson).
  - Factor of safety is unknown. Should be higher than 3.
  - Can do our own study to determine safety factor and negotiate with client.
  - Should do our own analysis based off numbers given.
    - Came out to 320 lb.
    - May not be that far off. This gives a factor of safety of 3 for each wheel.
- Minutes: more of a requirements sheet.
  - Should be changed into a chronological transcript.
  - Talk about it as if it was a summary of the entire meeting day.
- Get transcript and target spec done as soon as possible

### 3:10 – 3:20 Project Progress.

- Gantt Chart is well made
- Milestones
  - Client transcript
  - Client target specifications
- Progress
  - On schedule

### 3:20 – 3:30 Assigned Subsystem Input.

- Bearings
  - Create different load scenarios
    - Work out worst-case load scenario
- Gears
  - Found standard schematic
  - Fixed input equations
  - Input: set up different combinations to find required ratios
- Motor
  - Spec sheet is showing target torque
  - Always trading off torque and speed
    - Number of windings determines horizontal shift
    - Motor size determines vertical shift
- Wheel

- Tread life: Don't worry about it
- Commutator/bracket
  - Wait on CAD models

**3:30 – 3:35 Action Items. (Instructor and Mentor may leave at 3:30)**

Name	Action
Daniel	<ul style="list-style-type: none"> <li>• Get room for weekly client meeting</li> <li>• Email transcript, requirements matrix</li> <li>• Math modelling</li> <li>• Invite Odom to a meeting</li> </ul>
Jacob	<ul style="list-style-type: none"> <li>• Make requirements matrix</li> <li>• Math modelling</li> <li>• Follow up on Molly</li> </ul>
Gabe	<ul style="list-style-type: none"> <li>• Create Transcript</li> <li>• Math modelling</li> </ul>
Brad	<ul style="list-style-type: none"> <li>• Math modelling</li> </ul>

**Other:**

- Invite Odom to next meeting
- We need to understand our exact scope of the project
- Weekly meeting
  - Could use EP building

# 9/20/2017 - Meeting 4

Wednesday, November 15, 2017 8:09 PM

## Minutes 4

**Date:** September 20, 2017

**Time:** 3:00 pm – 4:15 pm

**Location:** Library

**Attendees:** Daniel Hien, Jacob Riggs, Brad Morris, Gabe Riggs

**Objective:** To debrief, clarify and conclude meeting minutes from Client meeting. Elaborate on and discuss Project Specifications. Begin process of Project design.

### 3:00 – 3:20 Client Meeting Minutes.

#### 1) Design Requirement Targets:

##### Bearing Life

- 20 – 30 khr life
- 4 – 5-year service
- 8-hour intervals

##### Motor

- 48 Volt at 80 Amps max
- Custom motor mounting bracket
- Other motor Specifications were provided through documentation

##### Recharging

- Minimize Electro-pitting

##### Vehicle Speed

- Horizontal: 8 ft/s
- Vertical: 4 ft/s

##### Case Studies

- Bearings
- Gears
- Motor

##### Gears

- Sealed and Lubricated

##### Wheels

- 8 inch diameter

#### 2) Compliance Standards:

- Industrial Standards

### **3) Deliverables:**

- 2-week skype interval
- Final:
  - CAD Package
  - Life analysis/Part Specifications
  - Functioning solution
  - Research and test data

### **4) Maintenance:**

- Whole Unit Replacement

### **5) Project Cost:**

- Development Cost: \$6000
- BOM Cost: \$2000

### **6) Client Provisions:**

- Existing Cad Model
- \$6000 Prototype Budget
- Volumetric Constraints
- Outsourcing for Prototyping needs
  - 3D Printing
    - Carbon
    - Metal
  - Sheet Metal Vendors
  - CNC Vendor
- Discounts:
  - KollMorgan
  - Quicksilver

### **7) Design Ideas:**

- Wheel Driven by outside motor
- Frameless motor embedded into wheel
- Frameless motor behind gearbox driving the sun gear
- Frameless motors as the planet gears

### **3:20 – 3:40 Project Specifications.**

- Postpone till next meeting (9/22/17)

### **3:40 – 4:00 Project Design.**

- Motor Drive system and subsystems.
  - Motor
    - Torque
    - Speed

- Max Duration
  - 48 Volt Max
- Wheel
  - Tread
  - Diameter
- Commutator
  - Bracket Mount
  - Mitigate Electro-pitting
- Gearbox
  - Life
  - Durability
  - Size
  - Ratio
- Bearings
  - Loads
    - Axial
    - Radial
  - Mitigate Electro-pitting
- Subsystem assignment.
  - Gabe: Motor
  - Daniel: Commutator and Wheel
  - Jacob: Gearbox
  - Brad: Bearings

#### 4:00 – 4:05 File Structure.

- Daniel organized Shared Drive.

#### 4:05 – 4:10 Action Items.

Name	Task
Gabe	<ul style="list-style-type: none"> <li>• Needs-Matrix Draft</li> <li>• Research assigned subsystem</li> <li>• Client meeting minutes</li> </ul>
Daniel	<ul style="list-style-type: none"> <li>• Research assigned subsystem</li> <li>• Circulate Minutes</li> </ul>
Jacob	<ul style="list-style-type: none"> <li>• Research assigned subsystem</li> <li>• Meet with Molly</li> </ul>
Brad	<ul style="list-style-type: none"> <li>• Research assigned subsystem</li> </ul>

#### 4:10 – 4:15 Round Up (Q & A).



- What is the desired Tread life?
  - Need to contact and ask Client.
- Can the wheel diameter be changed?
  - Need to contact and ask Client.

# 9/13/2017 - Meeting 3

Wednesday, November 15, 2017 8:09 PM

## Minutes 3

**Date:** September 13, 2017

**Time:** 3:50 pm – 4:35 pm

**Location:** Senior Design Suite

**Attendees:** Daniel Hien, Jacob Riggs, Brad Morris, Gabe Riggs

### 3:00 – 3:10 Research.

- look into planetary gear manufacturers
- Discussed multiply types of motors
- Discussed gear ratios of planetary gear sets

### 3:10 – 3:25 Client Agenda.

- What are the part specifications
  - current blueprints, existing cad models
- torque, speed, axial load, longevity, power supply, frequency
- Assembly budget, negotiable
- current weight vs. desired weight
- volumetric constraints
- heat levels, operation range
- noise level
- dust and particulates (sealing required)
- operating conditions
- units
- budget breakdown
- timelines outside of capstone deliverables
- cosmetic appearance
- compliance standards

### 3:25 – 3:30 Travel Plan.

- Departure: Sunday, 18th, steam plant parking lot, 2:00 Swenson will meet with a university vehicle
- will be back on monday at 5:00 or 6:00
- will have one meeting: update Dr. Swenson, no need of recording, casual

- Monday morning we will have a meeting

### **3:30 – 3:40 Project Schedule.**

- due dates will be bottom of list, different color
- discussed snapshot day
  - Deliverables: pictures, client meeting, etc.
- will send weekly updates of project schedule, beginning of week
- will have better version by next Monday

### **3:40 – 3:50 File Structure.**

- Will do after client meeting

### **3:50 – 3:55 Action Items.**

- Jake: meet with Molly
- Brad: working on gant for wednesday
- Daniel: verify meeting with Hans, email Dr. Rosay for team about monday absence
- Gabe: Develop Client agenda, give jake meeting minutes and agendas

### **3:55 – 4:00 Round Up (Q & A).**

### **Other.**

- durability of bevels is questionable
- How to have excel display current date for Gant chart
- should have a pre meeting monday morning
- team picture
  - semi-casual
  - first Monday of october

# 9/8/2017 - Meeting 2

Wednesday, November 15, 2017 8:08 PM

## Minutes 2

**Date:** September 8, 2017

**Time:** 3:00 pm – 3:30 pm

**Location:** Senior Design Suite

**Attendees:** Dr. Swenson, Coleton Bailey, Daniel Hien, Jacob Riggs, Brad Morris, Gabe Riggs

### Project plan:

- Snapshot day one
- Client interview

### Contact:

- Can start contacting client
- prefer email.

### Travel:

- Friday 22 or Monday 18, (Monday is preferred), backup plan is 22
- Budgeted
- Should have agenda for meeting client
- University vehicle
- Exact plans not determined

### Other:

- Shop training
- Decide time to meet with instructor/mentor
- Signed team contract
- Put draft schedule as far as snapshot day one
- Think of categorical questions for client
- Research planetary gears and motors
  - Thermal heat transfer balance
    - Ask client about thermal duty cycle requirements
    - Ask about operating environment
  - Divide everything up functionally
- Be liberal with lab books
  - Write however you want

### Agenda tips:

- Can write it in email

# 9/5/2017 - Meeting 1

Wednesday, November 15, 2017 8:06 PM

## Minutes 1

**Date:** September 5, 2017

**Time:** 3:00 pm – 4:00 pm

**Location:** IRIC Building

**Attendees:** Daniel Hien, Jacob Riggs, Brad Morris, Gabe Riggs

## Member Introduction.

- Discussed personal goals for project.
- Discussed personal project learning outcomes.
- Discussed reasons for choosing project.

## Team Name.

- Collectively decided the team name to be “The Basti-Boys”.

## Individual Roles Clarification.

- Treasurer/Librarian: Jacob Riggs
  - Documentation, file management, and budgeter.
- Liaison, Draft checker, and Editor: Daniel Hein
  - Primary contact. Quality control over written documents and drawing packages.
- Secretary: Gabe Riggs
  - Writes agendas and keeps track of minutes.
- Project Coordinator: Brad Morris
  - Keeps everyone on task during meetings. In charge of project scheduling.

## Polish Up Team Contract.

- Discussed project mission statement. Suggested, “Our goal is to meet the standards and criteria of our client” or something along those lines.
- Team roles were edited but the rest of the of the contract was acceptable.

## Action Items.

- Deliver contract on Friday.
- Daniel is to Email the Gant Chart to Brad.
- Gabe is to create an Action Register.
- Whole team is required to begin research on: gearing, motors, bearings and whatever else that will prove necessary for the project.
- Reserve room in library for next meeting on Wednesday.